

HVAC Industry

2021 Annual Report

The last 10+ year cycle has been led by a normalization of residential HVAC demand, with above average growth here off of a materially depressed base, while the commercial business lagged alongside, fundamentally challenged by secular trends around building owner productivity, though we see the potential for a "pivot" in the next 10 years. Given the absence of a material drawdown in residential despite the indicators, we believe demand is now above normalized, close to peak, and will remain volatile. There is less visibility into commercial except on a high level, with systems now aged from the late 90s real estate boom coming due for evaluation in an environment where IAQ, and, more tangible, ESG, are both catalysts for a pull forward of timing around penetration of the integrated building systems model. We also see less risk of disruption of competitive behavior in a commercial market that is more direct and where there is more technology differentiation. We think JCI is best placed to benefit from these trends, but remain Neutral as the stock has recently moved to reflect a more optimistic outlook, in our view. We also remain Neutral on CARR, but prefer it to highly valued peer TT (also N rated) as we see a disconnect in valuation that should narrow over time, while we remain UW on LII as we believe the residential story is less attractive and see limited benefits/unfavorable exposure on the commercial unitary side, not as short cycle as one would expect as per the '08/'09 experience.

- **US Resi: demand above normal in '20 "cycle in a season"...**The '20 selling season ended up being a cycle within a season with an unusual mini cycle of pent-up demand that ended with an 11% growth year that is materially better than the indicators would suggest, helped by a pre-buy kicker in 4Q. After a LSD '19, most expected similar late in the cycle growth, if any, pre-COVID, and sure enough 1Q was down, though things ramped hard off of an early season trough to finish strong. Some view WFH as the driver, and the installed base utilization as probably up meaningfully as a result, but our analysis suggests the structural impact from this phenomena is not enough to change the shape of the cycle. Of the incremental WFH participants, after taking into account co-habitation with only a percentage of those homes with AC and only a percentage of those that actively manage their HVAC systems, the magnitude of the impact gets small in the context of the 15-year machine useful life.
- **...with '21 risk to the downside versus OEM forecasts, super cycle looks over...**Along from the high base, with an expectation for still high U/E, and low consumer confidence, we think 2021 is at risk of recoupling to the indicators, which would suggest a down year. Housing is solid, which is a partial offset, but not enough on its own to drive growth given the COVID-19 inventory planning headwind we expect. In our view, '21 will be a "tale of two halves," with 1Q promised to be strong on loading ahead of price increases and a refreshed premium around availability, while 2H will give it all back; the question is to what magnitude, and while it's always weather dependent, with the channel load, the risk is to the downside. Pre-buy will play a role again in '22, which we see as a more significant factor than standing OEM expectations, but '23 will reverse. Ultimately we see a unit market for replacements/add-ons by '24 that is around '18/'19 levels at that stage, and growth beyond in line with installed base growth in the LSD.

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- **...share shift permanent or temporary?** Availability moves up the most important element of contractor decision after LII tornado and Goodman COVID experience. 2020 was not only a year of inter-season volatility, but also one of material share shift, following a 2019 in which LII donated share on the back of the tragic tornado in Iowa. A recent survey from the HARDI highlights that availability is now top of the list, a material change from a past in which over-capacity had meant plenty of product available on a JIT basis. This is not too surprising in the context of what just happened with COVID but also goes against the historical notion of stubborn brand loyalty. Keep in mind that differences between “sell in” and “sell through” affect comparability, but using the best information that we have shows that Goodman/Daikin was the main loser, due to COVID-19 complications, share we think went to Rheem. From there, it would appear Carrier gained some share but ultimately the shifts here are rounding due to differences in business model. For example, Lennox under-grew the industry in 2H but this was a function of lower sell-through in the 10% range, while the 20% growth for independent business was more in line, though we note that Lennox should have had an easier comp as they could have used the opportunity to regain some lost share and seemingly did not. Looking ahead, we do not see Goodman, the historical market leader who has benefitted from past regulatory transitions, taking the share loss in stride and see potential for an aggressive approach over the next few years. Somewhat related, beyond '25, we see potential for the hybrid ductless product, something Goodman/Daikin has product development around, to make inroads moving closer to cost parity with the standard ducted replacement, another potential driver of share shift.
- **Commercial:** Near-term challenges, but this cycle likely different/better than the last...The macro will likely hurt near term, as customers re-evaluate budgets in a challenging macro that lags the broader economy. However, after a low growth last cycle (2010-2019), an aged installed base sets the stage for an acceleration. The catalyst is COVID-19-related IAQ business, combined with, more tangible, in our view, an ESG-driven focus on system emissions footprint, with potential for real incentives to get the owner to invest. High level, we see the installations from a strong 1990s building cycle coming due for replacement, fertile ground for those that had pushed this event to the right with maintenance to re-evaluate and raise their quality in a ESG-centric world. As per the above, this is not an immediate catalyst, as fragmentation of building standards, and a myriad of choices to “get clean,” many of which are cheaper than system replacements, means this is less likely a dramatic wave in the immediate future, let alone low occupancy rates at present across offices and institutional buildings, a notion reinforced by CBRE management who recently said customers are on pause to get better post COVID visibility on occupancy. We see a 5-year CAGR of MSD % versus what we believe was an average LSD % last cycle. As for the verticals within, while unitary is a less expensive, shorter cycle product that typically leads out of recession, keep in mind that last cycle this market took ~5 years to recapture peak, not quite a “snap back” which means it’s not necessarily preferred at this stage versus the global integrated applied model.

- **...commercial competition heating up, consolidation likely on hold.** There will also be more competition in commercial, with all the major players having invested heavily in the last few years to refresh commercial product lines, and a mandate from Carrier, one of the Big 3, to gain market share. We think, at present, Trane continues to lead, while the market acceptance of the approach to integrated systems has been accelerated by COVID/ESG, is bringing the market towards JCI, and their “OpenBlue” platform is well timed. With all the moving parts and opportunities around COVID-19 and evolving landscape on commercial markets, with each company putting their best foot forward on organic investments, we see less interest in mergers.
- **Price/cost a watch item and while history suggests this is transitory in a disciplined industry, OEM mandates are fluid.** Raw materials costs have been easily passed through over time, especially in residential markets. However, with the variability around market share in the last few years with both LII and Goodman getting hit by unforeseen natural disaster-like events, a market that is peaking out, and contractors who are increasingly less brand loyal than we would have thought in the past, there is the potential for aggressive behavior. In residential, Daikin/Goodman, the market leader in units, lost a material amount of share in '20, and there is risk they get aggressive in a push to rebound, while the next few years of regulations could open the door for new technology, both risks to what has been a good run to record margins. On the commercial side, with a jump ball on ancillary services around IAQ, the installed base becomes more valuable, and here Carrier has a mandate to increase attachment rates, raising the risk that they “invest” in market share, which would come in the form of price.
- **Valuation:** HVAC sector valuation divergence with TT/LII the “rich” JCI/CARR “poor.” Since the four publicly traded players were established (CARR spin), the HVAC sector stocks on average has seen ~2,500bps outperformance versus the EE/MI Sector, with ~10.5x multiple expansion versus the sector at ~9.0-9.5x (ex-GE/DHR). Since beginning of July (more normalized), HVAC stocks have outperformed the group by ~1,800bps, while their multiples have expanded by ~5x vs EE/MI ~3.5-4x, driven by better performance in residential through year-end, and optimism around catalysts for commercial growth coming out of the COVID-19 experience, though there remains a material divergence among the players. CARR/JCI trade at material discounts to TT/LII on FY22 P/E, EV/EBITDA, and EV/FCFF. Some of this divergence, in our view, is predicated on what has happened the last cycle, and creates an opportunity in our view as cycle dynamics change. LII enjoys a higher multiple due to high growth for the last 10 years on residential exposure, though we do not think this is indicative of future performance, given peaking residential markets and increased competition. TT has been a share gainer with the cleanest pure play diversified portfolio, but is valued as such. CARR is similar to TT but has a lower multiple due to its fire and security business and high leverage, but looks like the best value to us today after the recent pullback. JCI also has a lower multiple due to fire and security exposure and has historically been a laggard on growth and margins, though we think partly because of our favor for commercial markets, and partly due to management actions on reinvestment to reinvigorate the portfolio, and now a major cost program, the next cycle should be sustainably better than last, but the recent run is now baking in these positives to a large extent. Lastly, on WSO, we move to Neutral (from UW prior) as execution on growth/margins has improved, and balance sheet optionality remains strong, leaving relative valuation as the main negative, not enough of a thesis, in our view.

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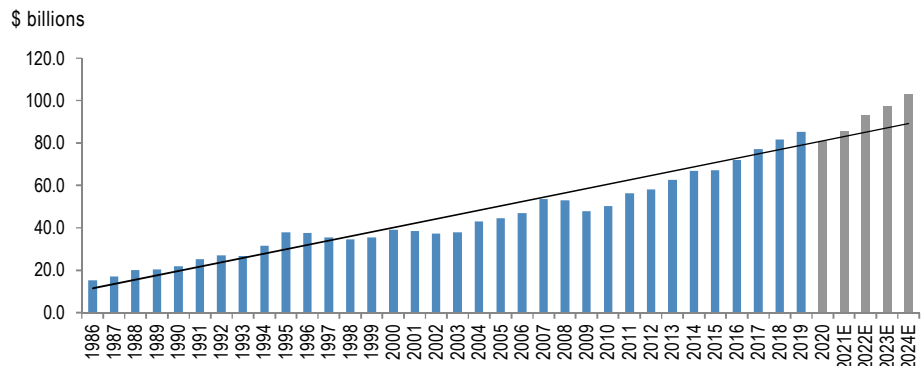
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HVAC Industry Investment Thesis

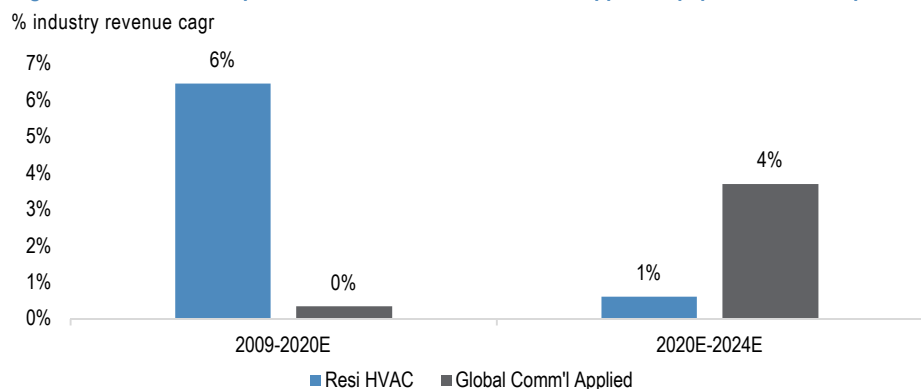
The global HVAC equipment market had seen almost uninterrupted recovery for most of the past decade, recapturing its long-term trend line in 2013 prior to the current downturn in 2020. In the US, before the outbreak of COVID-19, we had anticipated LSD growth for residential markets based on solid fundamentals and continued replacement strength, while for commercial HVAC we expected LSD/MSD growth. As with many sectors, the short-term performance for HVAC has been impacted, and below we see the decline in 2020 driving a down cycle for the first time since the financial crisis, though at roughly half the magnitude of declines, with residential surprisingly up 10% contrary to weak macro indicators. On the commercial side, the previous MSD medium-term growth (3-5 years) thought process is also changed with shifting work from home dynamics, construction projects being pushed to the right, and closures of restaurants and large public gathering locations. Importantly, like in other areas of the economy, we think the duration of this downturn is more short-lived, while beyond we expect the leadership to pivot from residential, which we expect to be saw-toothed and flat around 2020 levels, to commercial where cyclical forces and secular demand from a combination of IAQ/ESG related drivers, combined with an aged installed base, could make the next 5 years better than the last cycle.

Figure 1: Global HVAC Equipment Sales Have Moved Back To Long-Term Trend Line, Expect A Rebound in 2021



Source: Carrier, J.P. Morgan estimates

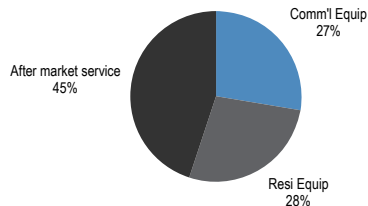
Figure 2: Resi HVAC Outperformance vs Global Commercial Applied Equipment Set To Flip



Source: AHRI, BSRIA, JARN, and J.P. Morgan estimates

Figure 3: HVAC Market Breakout

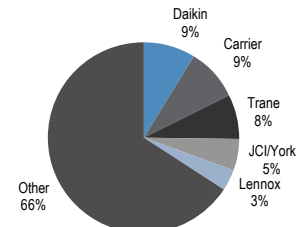
JPMc FY20 revenue breakout



Source: J.P. Morgan estimates.

Figure 4: HVAC Equipment Market Share

JPMc FY20 revenues



US resi market: volatility at the end of the favorable 10-year cycle, with “cycle in a season” in '20, including 2H re-stock...

US Resi markets were up 11% in 2020, after being up 5% in 2019, a slight decrease from the 7% growth seen in 2018, commensurate with the aging of the cycle. Indeed, 2020 started slow with the seasonally unimportant 1Q down, though declines accelerated with the onset of COVID-19, which produced a temporary buyer's strike, that was compounded by supply shortages as majors both voluntarily and involuntarily took down production. As the temporary "new normal" of stay at home, combined with elevated consumer savings rates, drove a rapid improvement in end user demand, it was clear coming out of 2Q that 3Q would come with an element of pent-up demand and that indeed was the case. With September up 50% y/y bringing growth of 26% y/y in 3Q, this suggests the channel was full, or even over-stocked, a dynamic that continued in 4Q with AHRI shipments accelerating to 36% y/y growth versus HARDI growth of 9%, which included a December that was up 20%. Feedback from the channel suggests even contractors made some early buys, partly due to availability concerns, but also partly due to coming price increases. This form of impromptu pre-buy is the first of its kind we have seen, and is key to a baseline for next year that now faces a tough comparison late in the cycle. The conversation does not stop there, as this growth comes despite economic indicators that suggested a decline of 20%, something more in line with '08/'09, which is what transpired in April/May of this past year, and we now see a replacement surplus that may need to be worked down next year, which brings us to our '21 forecast.

...raising risk around a decline in '21 versus OEMs calling for growth: a “tale of two halves”...

We are calling for a modest decline in '21 as replacement rates move back towards what the indicators suggest, which, along with the outgrowth versus trend in '20/pull forward, more than offsetting benefits of an ongoing uptick in housing. With CARR guiding to 30%+ growth in residential in 1Q, and with the comps discussed above, '21 will certainly see materially different growth when comparing 1H vs. 2H. Our standing view is a 1H that is up ~20% but a 2H that is down the same amount on the tough comparisons. The risk is to the downside, with the potential for weaker performance if the world returns to normal faster than expected (i.e., less time at home), or recouples to macro indicators which are indeed improved but remain below peak levels. Inventory in the channel is a headwind out of the blocks.

... ahead of expected '22 pre-buy though underlying trend closer to flat/down thru '23 as super cycle comes to an end

Moving beyond '21, we do not see much during COVID that “changed the cycle”. Work from home (WFH) has come up many times as a drive of increased utilization, potentially shortening the useful life, and our analysis shows that indeed, in terms of years, some units could have seen about a half year of pull forward. However, when taking into account 65% of homes with central AC, many of which are shared with dual employment, and then out of that only 55% that adjust their systems regularly, the number of those dynamic/active HVAC homes at the peak comes to about 15 million out of the 76 million or so installed base of homes with AC. Assuming that a little more than half of that goes back to work, this leaves 7-8 million houses with central AC, and who actually manage their thermostat, and may be changing their behavior permanently, pulling forward about one half years’ worth of utilization, not enough to change the course of a cycle. We refreshed our installed base aging analysis and looking at the age cohorts, we saw a peak in the 12+ year old vintage in 2018. While we acknowledge that there are units in the installed base that are over 15 years of age, meaning they’re not fully representative, the point is to look at evolution of the average age of rolling 15-year shipments as a leading indicator for annual shipments, as intuitively it would make sense that the older they get the higher the replacement activity should be. This seems to play out in the data, with the 12+ year old cohort peaking at 17% of the rolling 15-year shipment totals in 2001, followed by a peak in shipments four years later in 2005, which we normalize for 13 SEER pre-buy. With the 12+ year old cohort peaking at 23% of the rolling 15-year shipment totals in 2018, this would suggest to us a peak in industry shipments in 2022, coincidentally at the same time as the next regulatory change, following which we’d expect the industry to decline for perhaps 2-3 years. In other words, the residential “super cycle” off of the hard bottom in '08/'09 looks like it has come to an end. Keep in mind that looking forward, another step up in energy efficiency standards in '23 will likely drive a pre-buy in '22, but then, as is customary, we see a collapse in '23, a recoupling to the trend line that we see in and around '19 levels, after which the industry likely grows in line with the installed base.

Market share shifts in '20: permanent or temporary?

2020 was not only a year of inter-season volatility, but also one of material share shift, following a 2019 in which LII donated share on the back of the tragic tornado in Iowa. A recent survey from the HARDI highlights that availability is now top of the list, a material change from a past in which over-capacity had meant plenty of product available on a JIT basis. This is not too surprising in the context of what just happened with COVID but also goes against the historical notion of stubborn brand loyalty. Keep in mind that differences between “sell in” and “sell through” affect comparability, but using the best information that we have shows that Goodman/Daikin was the main loser, due to COVID-19 complications, share we think went to Rheem. From there it would appear Carrier gained some share but ultimately the shifts here are rounding due to differences in business model. For example, Lennox under-grew the industry in 2H but this was a function of lower sell through in the 10% range, while the 20% growth for independent business was more in line, though we note that Lennox should have had an easier comp as they could have used the opportunity to regain some lost share and seemingly did not. Looking ahead, we do not see Goodman, the historical market leader who has benefitted from past regulatory transitions, taking the share loss in stride and see potential for an aggressive approach over the next few years. Somewhat related, beyond '25, we see potential for the hybrid ductless product, something Goodman/Daikin has product development around, to make inroads moving closer to cost parity with the standard ducted replacement, another potential driver of share shift.

Commercial: exposure to macroeconomic slowdown, with uncertainty around timing of bounce back...

This market is lumpier than Resi, and more of a macro call with exposure to business confidence. We saw a market we estimate at down LDD % in 2020, a significant slowdown from previous years MSD growth as COVID-19 accelerated the already slowing trends as we moved towards the mid-to-late stage of the cycle. This should be followed by LSD/MSD % growth in 2021, driven by a rebound in replacement markets, though there are a lot more questions on the commercial side with regard to school reopening, office space capacity, building safety regulation, and the bounce back of hard hit industries (i.e., hospitality, travel, sports and restaurants). Indeed, CBRE noted through their interactions with occupier clients around return to work occupations that they believe on a weighted average basis, clients will go back to the office at ~85% of where they were before, with weighted average headcount down ~15%, but there remains a psychological overhang around decision making while in the midst of COVID. They noted that occupiers are going to want to have some remote capability as a more formal part of the portfolio with a focus on even more flex space in this coming cycle. They are still looking for guidance around design and solutions but there is currently a pause in the decision making meaning the cycle will remain a cycle, as occupiers need to have a clear understanding of how the footprint of their real estate needs will evolve over time which is not completely visible yet. As usual, we expect a bounce-back in unitary markets first, though keep in mind the degree of recovery here was muted last cycle taking two years to recapture peak. Bottom line, a bit more cyclical here with exposure to the weakened general economy, but like residential, fundamentals were solid pre-COVID-19 and Commercial is positioned to outgrow as the economy recovers.

...but aged installed base along with IAQ/ESG catalysts suggest set up for this cycle is better than the last

Beyond the cyclical aspects of this market, we see an unusually strong bounce off of the bottom this cycle versus the '08/'09 time period in which the financial overhang, and much of this market, ties to housing trends, along with negative square footage per worker trends pressured non-residential construction investments. This time around, environmental (the "E" of "ESG"), and to a lesser degree, indoor air quality (IAQ) have combined to raise awareness around commercial systems, and floor space per worker should stabilize with distancing protocols. With commercial building one of the leading energy users, the time appears to have come for aggressive corporate and government policies to take aim and invest in improvements. In addition, the installed bases built in the US are appearing to reach a ripe age for replacement, 25 years past the 1990s building boom, fertile ground for an increase in activity. Bottom line, we see non-res HVAC markets as a relatively better growth story for the next 3-5 years, a reversal of fortunes versus the residential lead past cycle. Again, however, keep in mind that, as per the above, this should not be an immediate catalyst, as fragmentation of building standards, and a myriad of choices to "get clean," many of which are cheaper than system replacements means this is less likely a dramatic wave in the immediate future, let alone low occupancy rates at present across offices and institutional buildings,

Technology accelerating: SEER changes, hybrid mini-splits in residential, platform refreshes timed to meet COVID-19 related IAQ and ESG focus in commercial

The technology in HVAC remains evolutionary and mostly driven by regulations, with enough progression and emphasis though for the leaders to maintain a moat around potential disruptors. The past several years have seen higher levels of investment and product line refresh across the major players, and we are in the midst of one of the most material new technology environments we have seen in our two decades covering the sector.

For residential, next up is another change in SEER, for which OEMs are refreshing their product lines, along with refrigerant changes that had been expected in '23 but are looking like they are getting pushed to the right as part of a national standard perhaps put in place in '25. Most of the new product development here has been to meet regulatory deadlines, as opposed to a new type of killer app. However, and potentially in combination with these regulations, the hybrid ductless product for residential is a potential share gainer. The value proposition is to match the high efficiency inverter compressor based condensing unit in the smaller ductless cabinet with a traditional air handling unit, ideal for smaller lot sizes and multi-family. Daikin's FIT product along with competing products from Trane and Carrier are targeted at a potential inflection in this product category driven by another step up in cost from coming new ducted platforms.

As for commercial, over the past few years we have seen an acceleration in activity aimed at portfolio refresh almost across the board. Trane started this journey almost 10 years ago, focusing on delivering the right balance of progressive refrigerants and energy efficiency, while JCI has, since the introduction of the YZ chiller platform in 2017, shown a steady stream of new products across not only equipment but controls. Carrier also began its journey of re-entering the large chiller market in 2016 with investments accelerating as a freshly spun off entity, while Daikin was a standout at the 2020 AHR expo with a new rooftop unit up to 17 SEER as well as new units designed to fit the Carrier curb. Daikin also impressed at the AHR Expo with their new Applied products, their Aptitude/Magnitude lines as well as Rebel Applied in packaged rooftop and a new unitary unit as well. VRF has been all the rage when it comes to the debate of winners and losers, though we think all the majors have found a way to include an offering in their tool kit without much of a material impact on the market, with perhaps an edge to the Mitsubishi Electric/Trane JV (METUS), while we view LIIs JV with Midea as coming up short. Also related to LII, both Daikin and JCI have come up with competing products to the Raider emergency replacement product, while the narrow exposure to unitary affords less of an opportunity to serve an expanding IAQ/ESG related buildings opportunity. On this front, COVID-19 has accelerated customers' focus on IAQ, which is driving incremental innovations that are more "at the margin" when compared to the scale of an HVAC system, but more tangible is the ESG push that is putting a premium on the optimal system configuration to track, trace and cut the carbon footprint. We think those with an established systems strategy/portfolio like JCI and Trane would seem to be best positioned.

Price has been positive, intensifying competition in pockets something to watch

Pricing for the HVAC industry has been consistently positive over the past 15 years, with moderate inflation and steady industry growth an attractive combination. With steel and copper moving up in recent months, there is incentive for the OEMs to push price, and they have. This is not without risks, however, which are somewhat specific to the current landscape. Like LII a few years back, Goodman suffered from unforeseen circumstances this year, though according to a recent HARDI contractor survey, customers view these instances as selling events, an opportunity for them to get something extra from the OEMs to switch ranks – in other words, they are not blindly brand loyal. LII has learned that the hard way as their share recapture efforts hit a wall last year. The risk here is that Goodman, the largest player with a new plant footprint that essentially doubles capacity, gets aggressive to win back some of this share. They have certainly had success in past transitions, though we also note that players like Trane are more prepared than they were back then with low end "fighting brands." On commercial, Trane remains the leader, though JCI and Carrier are working hard to catch up. Commercial pricing has always been a bit softer than residential, given a more direct channel to a less fragmented buyer base, leading to more price transparency. While Carrier has heavily lifted around product refresh, with a steady flow of new offerings, they remain behind when it comes to integrated services. They have spoken to a 30% attachment rate on services, and the need to increase that to be able to address customer needs around COVID-19 and emissions in the "new normal," mentioning price as one of the tools in their kit.

Consolidation theme pushes to the right

The past year has seen some significant changes to the HVAC industry from an OEM perspective. Key properties in HVAC have consistently undergone various strategic changes, combinations and spin-offs over the years (York to JCI, Goodman to Daikin, Trane to Ingersoll Rand), followed by moves by all the majors to focus on HVAC, with Carrier coming out of UTX, and Trane splitting free of Ingersoll Rand, creating ~\$120 B in market cap of "clean" pure-play HVAC, the most we have ever seen. However, with the change in market dynamics from COVID-19, and most of the diversified players now pushing hard on new offerings to exploit the opportunity around the "new normal" in commercial markets, we see less rationale in the near term for a major combination.

Valuation and the stocks

Since the four publicly traded players were established (CARR spin), the HVAC sector stocks on average has seen ~2,500bps outperformance versus the EE/MI Sector, with ~10.5x multiple expansion versus the sector at ~9-9.5x (ex-GE/DHR). Since beginning of July (more normalized), HVAC stocks have outperformed the group by ~1,800bps, while their multiples have expanded by ~5x vs EE/MI ~3.5-4x, driven by better performance in residential through year-end, and optimism around catalysts for commercial growth coming out of the COVID-19 experience, though there remains a material divergence among the players. CARR/JCI trade at material discounts to TT/LII on FY22 P/E, EV/EBITDA, and EV/FCFF. Some of this divergence, in our view, is predicated on what has happened the last cycle, and creates an opportunity in our view as cycle dynamics change. LII enjoys a higher multiple due to high growth for the last 10 years on residential exposure, though we do not think this is indicative of future performance, given peaking residential markets and increased competition. TT has been a share gainer with the cleanest pure play diversified portfolio, but is valued as such. CARR is similar to TT but has a lower multiple due to its fire and security business and high leverage, but looks like the best value to us today after the recent pullback. JCI also has a lower multiple due to fire and security exposure and has historically been a laggard on growth and margins, though we think partly because of our favor for commercial markets, and partly due to management actions on reinvestment to reinvigorate the portfolio, and now a major cost program, the next cycle will be sustainably better than last, but the recent run makes it less attractive than CARR.

Residential HVAC Summary Views

2020 solid growth in Resi; “cycle within a season”

Resi industry shipments ended up 11% in 2020 versus LSD growth in 2019, with OEM revenue growth coming in at 9-10% (note the below excludes Rheem), slightly above the 7 year average of 7.5% and better than what would be implied by the macro. Replacement units grew at a LDD pace in 2020, helped by pre-buying late in the year, with new housing units up ~3-4%. Mix and price were again positive, contributing about a point to overall revenues. Commodity-related price increases enabled OEMs to garner price above inflation in 2019, which faded in 2020, but customer mix was up at most OEMs despite the weak economy. The year was a tale of two halves, with significant weakness in 2Q more than offset by a strong bounce back in 3Q/4Q.

Table 1: J.P. Morgan Industry Revenue Estimate vs. Public HVAC Growth Rates

% Y/Y Change

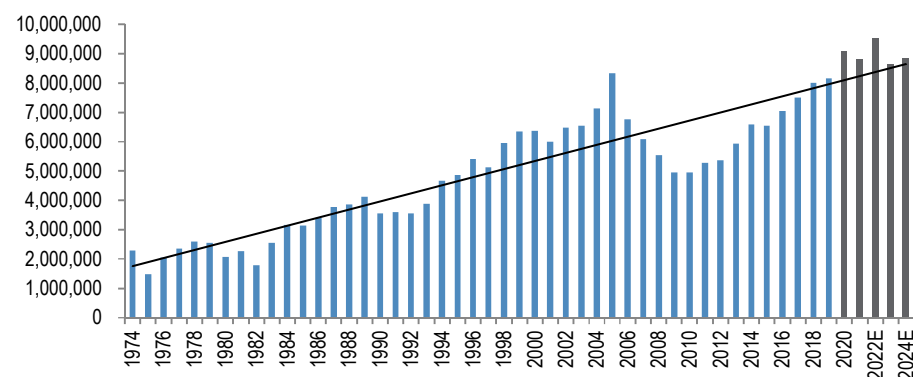
	2013	2014	2015	2016	2017	2018	2019	2020	Avg
WSO equipment SSS	9%	7%	7%	3%	4%	6%	3%	4%	5%
LII Resi HVAC Organic	15%	10%	8%	7%	7%	4%	3%	3%	7%
Trane Resi HVAC	0%	5%	6%	9%	11%	8%	5%	7%	6%
Carrier Resi	9%	7%	5%	4%	6%	8%	2%	12%	7%
Goodman/Daikin US Resi Unitary	9%	8%	-5%	10%	4%	12%	3%	0%	5%
HARDI Survey	7%	7%	6%	9%	6%	13%	6%	~3.5%	7%
Avg of above	8%	7%	5%	7%	6%	8%	4%	5%	6%
JPM Industry Proxy	12%	11%	3%	9%	7%	8%	3%	9-10%	~8%

Source: Company reports, HARDI, J.P. Morgan estimates. * =2013 Daikin/Goodman data are on a unit only basis (excludes price/mix).

Big picture, both 2018 and 2019 were above trend in many respects, and with acceleration in 2020 the industry remains above trend line. There is a lot more to the story than this, however.

Figure 5: Overall Residential HVAC Market Regained Trendline in 2017/2018, Unexpectedly Held Above in 2020, Expected to Rise Further into 2022, Followed by a Re-trace in 2023/2024

units



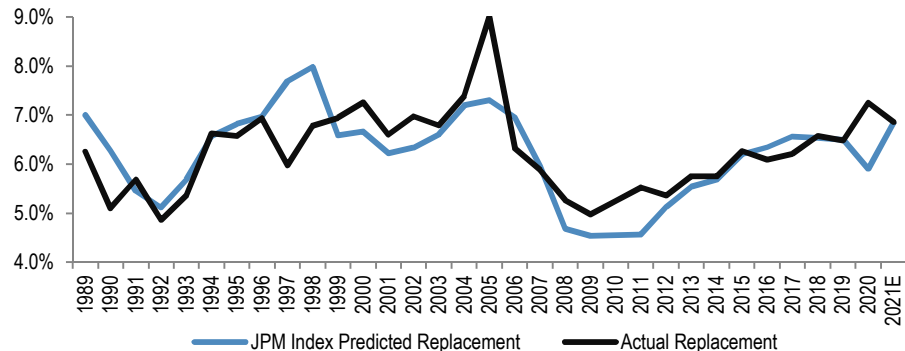
Source: AHRI and J.P. Morgan estimates.

Housing strengthened through 2020 and 2021 expected up DD; replacement rates up better than indicators would suggest

Housing momentum continued to be steady through 2019, seeing MSD type growth. Since the last cycle, starting in 2012, housing completions have seen MSD/HSD growth. Housing statistics around the pandemic were volatile but finished at SAAR ~1.29 million completions, representing ~2.5% growth y/y, while starts grew 7%, with single family units up 11.5%, and JPM's most up-to-date call is for 1.63 million starts in 2021, up 18% y/y. This was clearly not at all like the financial crisis, which saw 24%, 26%, and 29% declines in 2007, 2008, and 2009. Importantly, in 2019 replacement demand, which had been steadily rising as we neared the end of the current cycle, was near the high end of historical ranges (barring the 2005 pre-buy driven year), seen below, and in 2020 it reached an all-time high in absolute units, with the replacement rate itself hitting a new cycle high. In our view, replacement rates are primarily driven by existing home sales, which strengthened throughout '20, but also consumer confidence and unemployment, which were both negative factors.

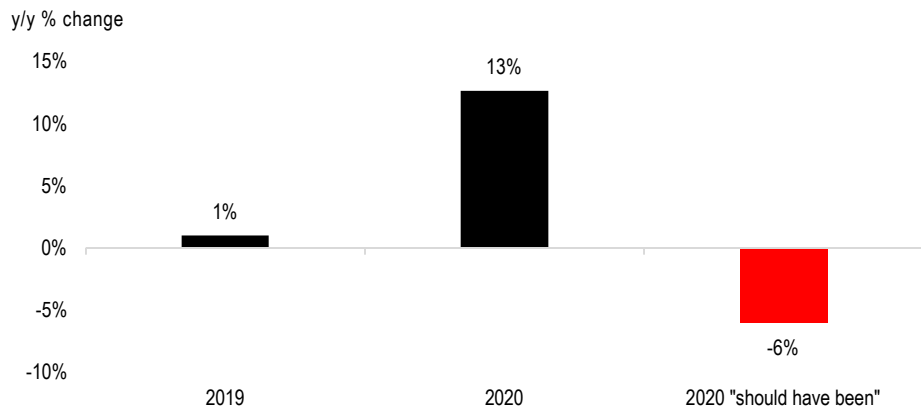
Our JPM replacement index, which considers consumer confidence, unemployment rate, and existing home sales, suggests a 5.9% replacement rate in 2020, down from ~6.5% in 2019, but the ultimate outcome was 7.3%, up from 2019 as actual replacement held up better than what the macro index is predicted, we believe a function of "stay at home" in COVID-19, a material increase in savings rates, which, combined with low interest rates, has also helped a housing market, key to consumers feeling good about investing in home systems like HVAC. We also see an element of a COVID-19 induced inventory planning situation in 2H20 as distributors pre-bought just in case industry production was hampered again in 2021.

Figure 6: JPM Index Implied Replacement versus Actual Replacement



Source: AHRI, Thomson Reuters University of Michigan, BLS, NAR, J.P. Morgan estimates

Figure 7: 2020 Resi HVAC AOR Held Up Much Better Than Macro Implied It Should Have

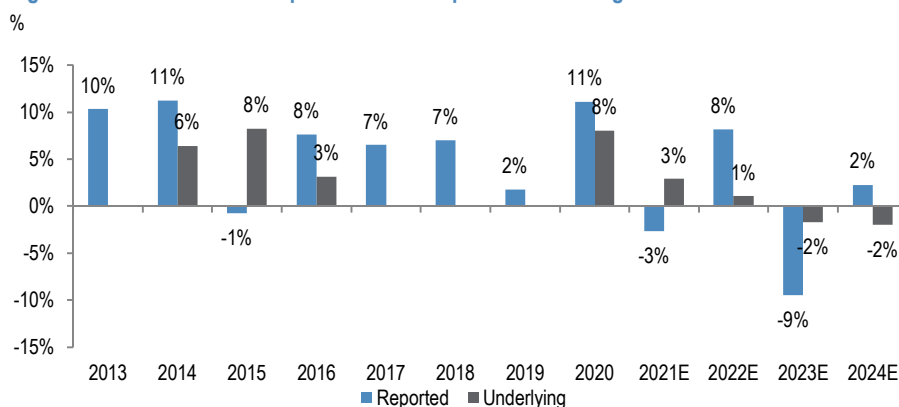


Source: J.P. Morgan estimates.

With shadow pre-buy in '20, we see volume down in 2021, as replacement recouples to indicators, '22 up on another, more regulatory driven pre-buy

We are updating our market estimates for the next several years, with the expectation of down LSD performance in '21 off of a better than expected '20 and then an up '22 on pre-buy. Indeed, '20 ended strong for industry shipments, characterized by what we consider to be COVID-19 inventory planning dynamics, as distributors built a just in case stock of units given uncertainty around the path of the virus through the winter, as well as ahead of coming price increases. The magnitude of pre-buy here was high relative to the market trend we estimate in the 3% growth range, when measured against prior experiences of 2005 and 2014 which were regulatory driven. Adjusting for the noise, we estimate underlying demand growth of 8% in 2020, followed by 3% in 2021 as replacement rates catch down to the macro and the industry laps the shadow pre-buy from 2020. Looking at 2014 through 2019, we saw strong replacement demand, with replacement rates (as a percentage of installed base) returning to the high end of historical levels as we characterize "normalized" growth as ~LSD, in line with the installed base. Prior to COVID-19, we had projected a few more years of "normalized" growth above this LSD range as momentum from macro factors and demand from the replacement cycle, but as the industry moves into and out of the late innings of the pent-up demand / housing echo bubble replacement boom, we see more of a "flat environment," which along with negative macro indicators is offset by a solid housing market and a regulatory driven pre-buy in '22 ahead of 2023 efficiency regs.

Figure 8: Total Resi HVAC Shipment Growth Expectations Through 2024



Source: AHRI and J.P. Morgan estimates. Note: We estimated that ~285K units of 13 SEER pre-buy was pulled into 2014, which increased 2014 growth by ~4% on the lower comp, so the "underlying" growth trend for 2014-2016 was smoother than the headline numbers, as depicted in the chart. For 2020, we estimated a COVID-19 inventory planning impact of ~250K units, which we assume reverses in 2021, showing an underlying growth trend in the 8% range for 2020 and 3% for 2021.

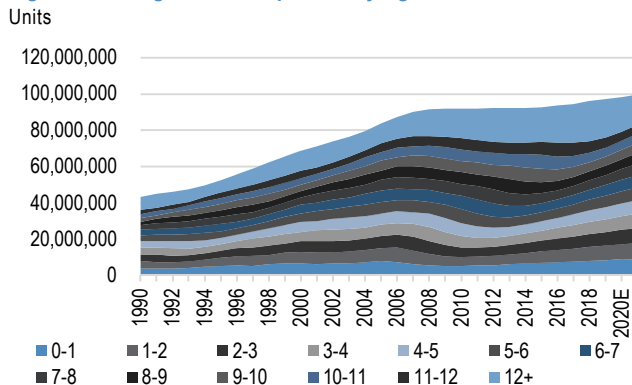
Table 2: JPM HVAC Industry Residential Equipment Revenue Model

	2013	2014	2015	2016	2017	2018	2019	2020	2021E	2022E	2023E	2024E
Splits Units, Y/Y	10.3%	11.2%	-0.7%	7.6%	6.5%	7.0%	1.8%	11.1%	-2.7%	8.2%	-9.5%	2.2%
Split Mix Impact	0.3%	1.0%	2.6%	1.1%	0.2%	0.0%	0.0%	0.5%	0.3%	0.6%	1.4%	0.0%
Splits Revenues, Y/Y	10.6%	12.3%	1.9%	8.8%	6.7%	7.0%	1.8%	11.6%	-2.4%	8.7%	-8.1%	2.2%
Splits Revenue Contribution	7.2%	8.2%	1.3%	5.9%	4.5%	4.7%	1.2%	7.9%	-1.6%	6.0%	-5.6%	1.5%
Furnace Units, Y/Y	16%	5%	3%	5%	6%	9%	1%	-3%	3%	3%	3%	3%
Furnace Revenue Contribution	2.7%	1.0%	0.6%	0.8%	1.1%	1.4%	0.2%	-0.5%	0.4%	0.4%	0.4%	0.5%
Components Units, Y/Y	14%	11%	1%	8%	6%	7.0%	1.7%	11.2%	-2.9%	8.1%	-9.7%	2.2%
Components Revenue Contribution	2.3%	1.8%	0.2%	1.2%	1.1%	1.1%	0.3%	1.8%	-0.5%	1.3%	-1.6%	0.4%
Price (like-for-like)	0.2%	0.1%	0.5%	0.6%	0.6%	0.6%	1.0%	0.5%	0.5%	0.5%	0.5%	0.5%
Total Industry Revenues	12.4%	11.1%	2.5%	8.6%	7.3%	7.9%	2.7%	9.7%	-1.2%	8.3%	-6.3%	2.9%
Ex pre-buy impact		7.7%	7.9%	4.4%				7.6%	2.7%	3.3%	-0.8%	-0.2%

Source: AHRI data, J.P. Morgan estimates.

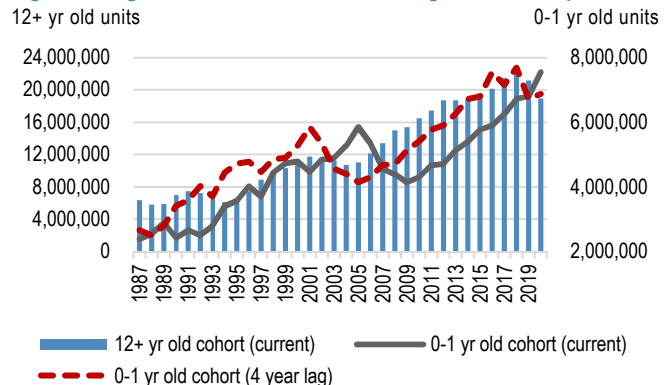
Supporting our outlook for a “flat environment” over the 2020-2024 period, with volatility in between, the rolling 15-year shipment totals, which are approaching 100mm in 2020, saw a peak in the 12+ year old vintage in 2018. While we acknowledge that there are units in the installed base that are over 15 years of age, meaning it's not fully representative, the point is to look at evolution of the average age of rolling 15-year shipments as a leading indicator for annual shipments, as intuitively it would make sense that the older it gets, the higher the replacement activity should be. This seems to play out in the data, with the 12+ year old cohort peaking at 17% of the rolling 15-year shipment totals in 2001, followed by a peak in shipments four years later in 2005, which we normalize for 13 SEER pre-buy. With the 12+ year old cohort peaking at 23% of the rolling 15-year shipment totals in 2018, this would suggest to us a peak in industry shipments in 2022, coincidentally at the same time as the next regulatory change, following which we'd expect add-on/replacement demand to decline.

Figure 9: Rolling 15-Year Shipments By Age Cohort



Source: AHRI, and J.P. Morgan estimates

Figure 10: Age of Installed Base Leads Changes in New Shipments



Source: AHRI, and J.P. Morgan estimates

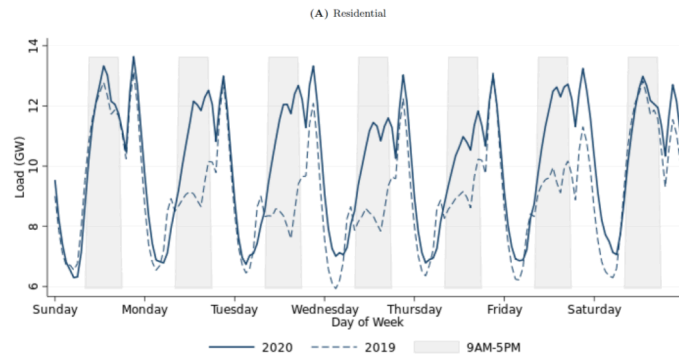
WFH does not change our cycle view

There is one aspect of the debate around whether or not COVID stay at home has changed the shape of the cycle, and if there was an impact from residential customers running their machines harder. The bottom line is that as we work our way down from the pool of candidates working from home permanently, which could have been as high as 50 million at the peak, some of which share a home while not all of which have with AC, while not everyone adjusts their systems, we get to a low impact on total usage in the context of the operating life of the system, and it will shrink over time as things normalize.

To help us level set the degree of impact, recent data and research shows that residential energy usage is indeed up, with the shift up in the traditional “duck curve,” with weekdays looking more like weekends. A recent study for the National Bureau of Economic Research by Steve Cicala suggests that patterns that used to distinguish work days from weekends have largely disappeared with residential consumption rising later in the morning to 16% higher during work hours than during normal times. The data is from Texas, a good sample state for HVAC. Keep in mind that this is total residential usage, and therefore the differences between those actually working at home and those that maintained a consistent pattern suggest that the per-unit usage change was more extreme than the 16% below. Either way, with residential usage up, clearly utilization of HVAC was higher.

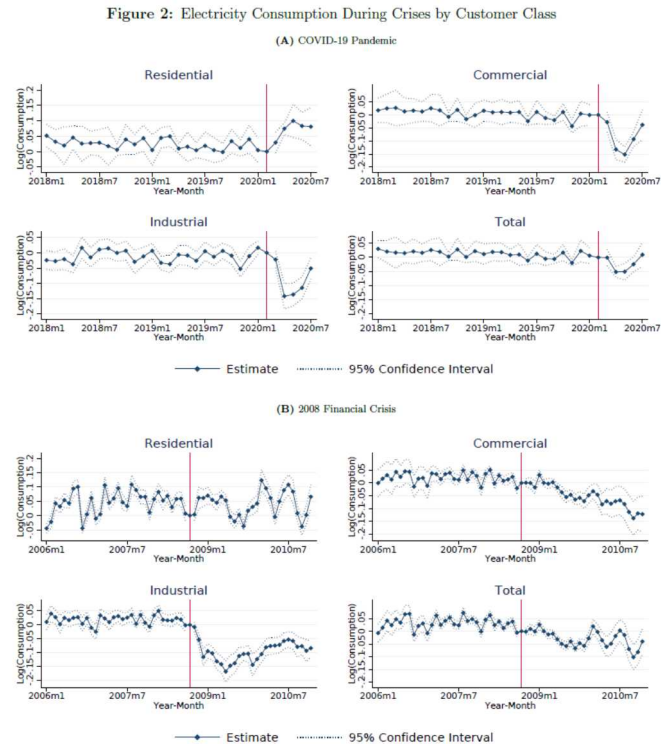
Figure 11: Texas “Duck Curve” Change Suggests More Power Was Used For Appliances Like HVAC

Figure 1: Temperature-Adjusted Electricity Consumption in Texas by Customer Class: April/May, 2020 versus 2019



Source: National Bureau of Economic Research by Steve Cicala

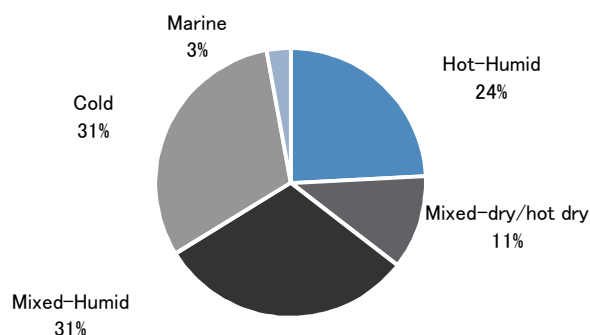
Figure 12: Residential Usage Showed A Different Pattern Compared To GFC, Another Example Of WFH Impact On Appliance Utilization



Source: National Bureau of Economic Research by Steve Cicala.

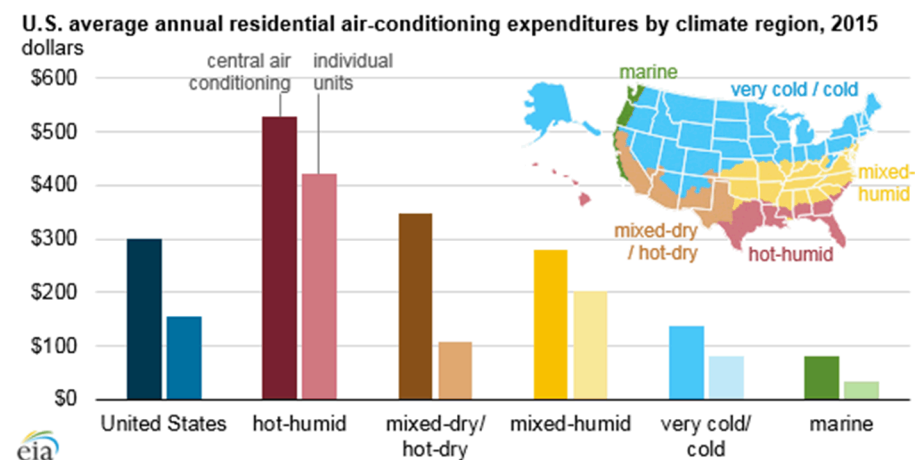
The question is how much higher, and to start we identify how many annual hours the average unit runs during the season? The base for the DOE SEER ratio, the de-facto regulatory minimum, is that the unit runs around 8 hours a day for 125 days, or 1,000 hours in the annual cooling season, essentially 4 months out of the year that would run from Mid-May to Mid-September, which is where the bulk of the HVAC shipments occur. There are regional differences, and we try and control for this by looking at annual spending on energy related to home air-conditioners as per EIA data. They estimate that operating costs for central units averaged ~\$300 in 2015, ranging from an average of \$525 in the hot-humid region in the Southeast to about \$60 in the temperate marine region along the West Coast. The more moderate mixed-humid region was closest to the national average. This we believe is the basis for the assumption of 8 hours a day for 125 days or about a 4 month cooling season. Without going deeper around cost of energy, we simply interpret this data as signifying that those in “AC country” use their machines 1.6x more than the average, and we therefore apply that multiple to the base case assumption of ~1,000/year. Keep in mind that, as per the EIA Residential Building Characteristics data, about 24% of homes with central AC are in “hot-humid” areas, with another 11% in “mixed-dry/hot-dry,” so only ~35% of homes are in what we would consider to be “AC Country.” In other words, the real “leverage” on this theme is isolated to only a part of the installed base, namely AC country and the “mixed-humid” area which in total represents about 65% of the country’s installed homes.

Figure 13: 66% Of the US Installed Homes With Central AC Are in or Close to "AC Country"



Source: EIA.

Figure 14: Average Annual Air Conditioning Spending, a Gauge of Utilization Is Understandably More in Southern Climates



Source: EIA.

Multiplying the 1.6x across the work days suggests upwards of a 35% impact to total AC hours run per unit. We then take the difference and compare to the average hours run per year and it shows that this year would have pulled forward about 2% of annual operating hours for those that have changed their behavior or about 54 days out of a 125 day season.

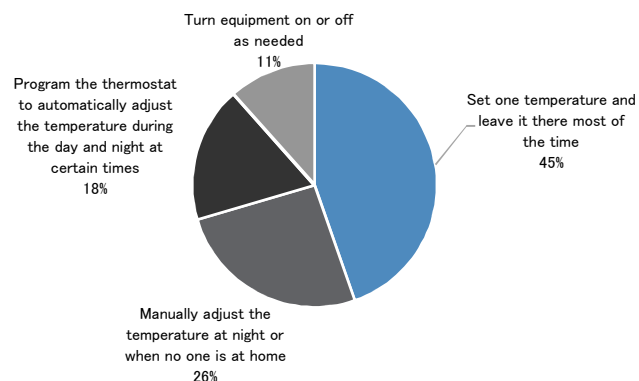
Table 3: Simple Illustrative Analysis Of Harder Run Time and Its Impact on Unit Utilization

Average	Weekend days	Work days	Total	Diff	New Average	Weekend days	Work days	Total	Diff
Hours	11	7		58%	Hours	11	11		0%
Days					Days				
May	4	13	17		May	4	13	17	
June	8	22	30		June	8	22	30	
July	8	23	31		July	8	23	31	
August	8	23	31		August	8	23	31	
September	4	12	16		September	4	12	16	
Total Season Days	32	93	125		Total Season Days	32	93	125	Change
Total Hours	352	648	1,000		Total Hours	352	1,023	1,375	37%
Average			8		Average			11	
								% of Total Useful Life	2%

Source: J.P. Morgan estimates.

It's also important to keep in mind that not everyone adjusts their HVAC system for when they are home versus when they are not. According to EIA, the vast majority of homes with central AC have a thermostat, with about 64% having a programmable thermostat. However, not everyone manages the temperature closely. 45% of users set one temperature and leave it there most of the time, 26% manually adjust the temperature, while 18% program the thermostat to automatically adjust, while 12% turn it on and off as needed. The takeaway here is that about 55% of the addressable pool would be adjusting to run their machines harder due to a change in circumstance.

Figure 15: About 55% of Central HVAC Users Actively Manage Their Cooling



Source: EIA.

Lastly, we need to identify the magnitude of the shift in the base of ~150 million US employees. The US Census American Community Survey (in commuting characteristics section) noted that in 2019, 5.7% of US workers worked from home, and most news reports suggested remote workers got up to ~60% in 2020, above a 2017-2018 BLS survey which highlighted that about ~45% of jobs were able to telework. We use 50% as our number, representing about 75 million people for the peak. There are about 128 million households/138 million housing units in the US, but some of these are shared. Data shows that out of the 82 million “families,” about 64% of which are dual income, in other words, sharing their home or about 52 mm employees that are served thru one house/system. Subtracting the extra person from that group gets us to a total addressable WFH group of ~50 million at peak.

Tying it all together and taking into account the 65% of homes with central AC, and another 55% that adjust their systems regularly which gets you to about 15 million out of the 76 million or so installed base of homes with AC which would see an annual seasonal increase per unit of about 37% or pulling ahead about 54 days or about 3 months’ worth of seasonal operations. When the dust settles, assuming that a little more than half of that goes back to work, or 20% of the workforce working at home on a multiple-days basis, this means about 7-8 million house with central AC, and who actually manage their thermostat, will be changing their behavior permanently, pulling forward about one half years’ worth of utilization.

Table 4: About 15 Million Homes with AC Could Have Seen Increased Utilization During COVID

units in mm

		Notes
Total employed	150	
WFH at peak	75	50%
Families	82	
Sharing	52	64%
Impact on Pool	(26)	
Addressable households	49	
% with AC	32	65%
% that Adjust Systems	17	55%
Normal	20	40% of peak
% with AC	13	65%
% that Adjust Systems	7	55%
Installed base	76	
% Of Installed Base at Peak	23%	
% Of Installed Base at Normal	9%	
Other Info		
Increase per unit on average	375	
Added Ops In Days	54	
As % of Season	43%	

Source: J.P. Morgan estimates.

2021: stocking volatility makes this a "tale of two halves"

For '21, information from HARDI and AHRI tells the story well, with HARDI "sell through" up 9% and AHRI "sell in" up 30-35% in Q4. This 2H performance is one of the most dramatic we have seen in the history of the data, lining up to look not as extreme as 2005/2006, but with more volatility than the 2014/2015 pre-buy.

Table 5: Comparison of Current Pre-buy to Historical Occurrences

y/y % change

	2005	Trend	Diff	2014	Trend	Diff	2020	Trend	Diff
Jan	-1%	8%	-9%	24%	7%	17%	5%	6%	-1%
Feb	7%	8%	-1%	12%	7%	5%	6%	6%	0%
Mar	7%	8%	-1%	11%	7%	4%	5%	6%	-1%
Apr	-12%	8%	-20%	3%	7%	-4%	-14%	6%	-20%
May	-19%	8%	-27%	9%	7%	2%	-22%	6%	-28%
Jun	1%	8%	-7%	4%	7%	-3%	5%	6%	-1%
Jul	21%	8%	13%	-2%	7%	-9%	12%	6%	6%
Aug	41%	8%	33%	4%	7%	-3%	23%	6%	17%
Sep	47%	8%	39%	31%	7%	24%	50%	6%	44%
Oct	77%	8%	69%	20%	7%	13%	64%	6%	58%
Nov	71%	8%	63%	12%	7%	5%	31%	6%	25%
Dec	47%	8%	39%	55%	7%	48%	12%	6%	6%
Total	17%	8%	9%	11%	7%	4%	11%	6%	5%
Next twelve months									
Jan	77%			31%					
Feb	14%			20%					
Mar	-8%			7%					
Apr	-21%			3%					
May	-8%			-10%					
Jun	-16%			-9%					
Jul	-29%			2%					
Aug	-11%			10%					
Sep	-40%			-10%					
Oct	-51%			-9%					
Nov	-48%			-8%					
Dec	-35%			-19%					
Total	-19%			-1%			??		

Source: AHRI, J.P. Morgan estimates.

We add AHRI data as well as Carrier versus WSO sales to gauge how channel inventories are positioned. Here we can see that when comparing historical pre-buy to NTM, y/y there are difficult comps to overcome, leading to growth that was pushed forward in year 1 to become normalized on a 2-year stack. Our pent-up analysis shows there is a 5% overhand going into '21 in line with the pre-buy we saw in '14. However unlike '14, in '20 we saw much more volatility intra-year. On CARR vs. WSO, they are diverging again with CARR 4Q growth of 25% and WSO growth of 17%. The 17% growth in US resi roughly mirrors what Carrier discussed about shipments from distributors to dealers growing around 20%, and given the decline in inventory at WSO, resi should have a strong 1Q21 with channel loading ahead of concerns of availability and potential price increases. However with WSO reporting overall HVAC equipment up 9% in Q4, this suggests light comm'l and international HVAC remained down y/y.

Table 6: Scenario Analysis (units in thousands) Shows Shipments Outgrowing End Demand

	2019	2020	AHRI Y/Y	HARDI Y/Y	Pent Up Demand Assuming 6% Mkt Growth
April	720	618	-14%	-19%	145.5
May	977	760	-22%	-10%	276.0
June	1,038	1,088	5%	24%	<u>12.2</u>
Pent Up Demand Still Left	2,735	2,465	-10%	0%	433.7
July	876	982	12%	8%	<u>(53.1)</u>
Pent Up Demand Still Left					380.6
August	749	924	23%	5%	<u>(130.5)</u>
Pent Up Demand Still Left					250.1
September	587	879	50%	14%	<u>(256.9)</u>
Pent Up Demand Still Left					(6.8)
3Q Total	2,212	2,785	26%	9%	
October	492	808	64%	2%	<u>(286.6)</u>
Pent Up Demand Still Left					(293.4)
November	439	575	31%	4%	(109.6)
December	487	544	12%	22%	<u>(28.0)</u>
Pent Up Demand Still Left					(431.0)
4Q Total	1,418	1,927	36%	9%	
% LTM units >					5%

Source: J.P. Morgan estimates, Company data.

Table 7: WSO Inventory vs. CARR Organic

\$ in millions

	Sales	Same-store growth	COGS	Actual inventory	q/q chg	Inventory purchases (COGS + chg in actual inventory)	y/y chg	CARR organic growth	WSO Resi HVAC same-store sales growth	Cumulative Difference (CARR-WSO)
1Q18	927	6%	690	810	6%	739	3%	11%	7%	4%
2Q18	1333	4%	1006	873	8%	1069	9%	5%	7%	2%
3Q18	1296	5%	972	811	-7%	909	-4%	9%	7%	4%
4Q18	991	6%	736	837	3%	762	10%	12%	3%	13%
1Q19	931	0%	692	894	7%	748	1%	5%	2%	16%
2Q19	1372	1%	1038	967	8%	1112	4%	3%	4%	15%
3Q19	1395	3%	1054	970	0%	1057	16%	-3%	6%	6%
4Q19	1072	1%	805	921	-5%	756	-1%	-3%	1%	3%
1Q20	1009	2%	754	943	2%	776	4%	-11%	4%	-13%
2Q20	1355	-6%	1030	854	-9%	941	-15%	-13%	0%	-26%
3Q20	1537	7%	1156	885	4%	1187	12%	46%	19%	2%
4Q20	1155	8%	866	794	-10%	775	3%	25%	17%	10%

Source: Company reports and J.P. Morgan estimates.

'21 a story of two halves, downside risk to OEM +LSD/MSD forecasts: We show below how we see FY21 playing out taking into account ongoing volatility around growth comparisons, which will be favorable in 1H and then highly unfavorable in 2H, one of the greatest instances of volatility we have seen on record. Using LII and WSO as a gauge, we show below a chart with normal seasonality, and we base our general forecast on more normal buying behavior. We note that Carrier guiding for 30%+ growth in 1Q suggests material pre-season channel loading.

Table 8: Seasonality proxies

	1Q	2Q	3Q	4Q		1Q	2Q	3Q	4Q
Industry Units	21%	35%	27%	17%	y/y	38%	64%	-22%	-17%
LII normal	20%	33%	28%	19%		-7%	44%	-7%	-16%
WSO normal	20%	28%	29%	23%		-5%	41%	4%	-22%
CARR (e)	"low 20s"	"Low 30s"	"high 20s"	"low 20s"					
Industry Units '20	21%	27%	31%	21%					

Source: J.P. Morgan estimates, Company data, AHRI

We use two methods, using AHRI data to compare what "should have been" versus "what was" to show below the potential overhang heading into '21 and ultimately what shipments should look like. We look back at 2018 as a base that looks seasonally normal when compared to the above. In the first exercise, we use normal q/q trends starting in 1Q19 and play it through, showing limited difference in what should have been versus what was the divergence is more material in 2020, and at the end of the year shows an over-shipment of ~81k units or about 1% of what demand would be if this normal seasonal trend continued, and suggests that, without that overhang, y/y growth should be ~5%. We then show below what would have been implied on a mere 3% growth rate, about in line with the installed base, which calculates a more material impact, though this suggests a y/y decline. Keep in mind that the economic indicators are net negative when compared to 2019 so we tend to take the more cautious approach. In the first approach we would see 1H grow by 20-25%, with a 10-15% decline in 2H while in the second approach we would see 1H up 10-15% with a 2H down 15-20%.

Table 9: Normal Sequential Seasonality Implies ~4% Industry Growth...

units in 000s

	2018	2019	2020	2021E	2021E Post Inv Impact
Should be	8,021	8,247	8,899	9,537	
		3%	8%	7%	
Was	8,021	8,161	9,066	9,537	9,456
		2%	11%	5%	4%
Over/(under) stock		(86)	167		
Cumulative			81		
% of Annual			1%		

Source: AHRI

Table 10: ...But Assuming 3% Trend Line Suggests a Correction

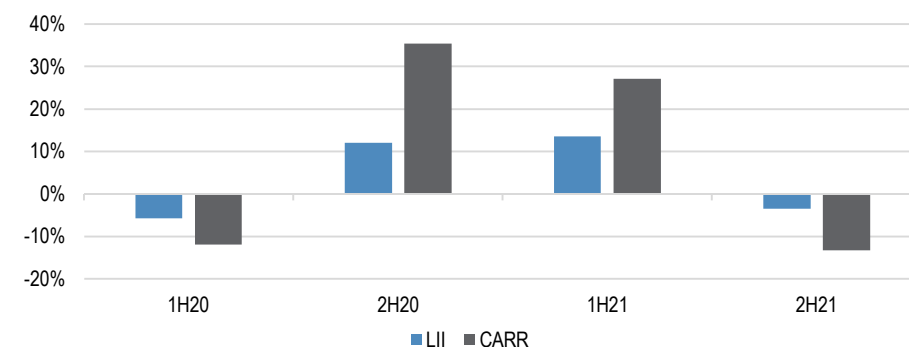
units in 000s

	2018	2019	2020	2021E	2021E Post Inv Impact
Should be	8,021	8,261	8,509	8,764	
		3%	3%	3%	
Was	8,021	8,161	9,066	8,764	8,307
		2%	11%	-3%	-8%
Over/(under) stock		(100)	557		
Cumulative			457		
% of Annual			5%		

Source: AHRI.

Figure 16: Volatility Continues into '21 Either Way

%



Source: Company reports and J.P. Morgan estimates.

Upside case: housing replacement bubble demand sustains growth in 2021 while extended unit life stretches cycle further

We also evaluate potential upside to our growth forecast. The two most impactful elements of a bull thesis supporting upside to this number are: 1) the housing bubble of ~15 years ago turning into a replacement bubble, and 2) ongoing pent-up demand from repaired units during the recession, though it is our view that these are both now late innings. We walk through our math for each below, but all-in we see an upside scenario of MSD HVAC shipment growth for 2021, above our base case estimate for a LSD decline and what we would consider normalized installed base growth of +LSD.

Table 11: JPM Upside Case Summary- 2021

%	
Normal Installed Base Growth (2003-2020)	~2.3%
"Replacement Bubble" Upside (2021)	2.0%
Remaining "Pent-Up Demand" Upside (2021)	0%
Annual Replacement Growth Upside Case	~4.3%
Annual Housing Growth (JPM Base Case)	13%
Annual Replacement Growth (Upside Case)	4-4.5%
Annual Total Shipment Growth (Upside Case)	~5.5%

Source: J.P. Morgan estimates

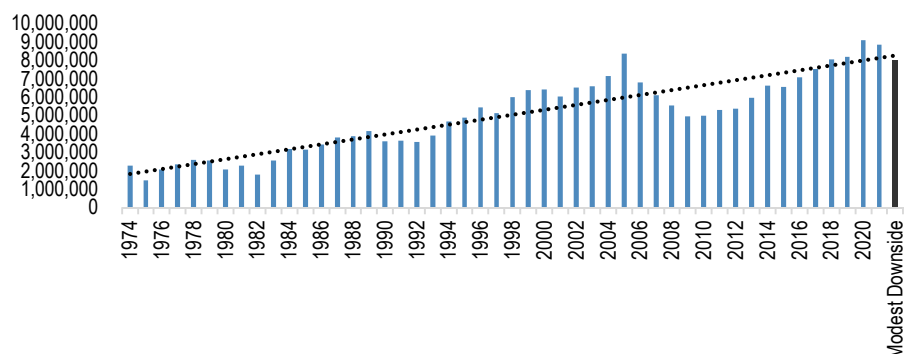
We also note that there has been increasing talk recently throughout the channel on longer unit life, driven by increased quality of manufacturing and better contractor performance/education, which is allowing for extended warranties. This type of thinking is accelerated even further when you take into consideration work from home capacity constraints and businesses shut down, leading to even less usage and longer equipment life. While difficult to validate empirically, and a source of some level of disagreement among key players on whether units truly are lasting longer, we note that if units are lasting a couple of years beyond the 12-15 year timeframe, this could represent upside and a more extended cycle for residential HVAC. Recently during the Carrier Investor day, management noted that they plan for an 18-year replacement cycle, giving credence to the past couple of years of inching up the lifespan of equipment. This said, geographic considerations also must be taken into account, as part of the housing bubble related growth was in the Sun Belt, where useful life is likely lower than the rest of the country. In our upside scenario above, we are only dialing in about one-third of the potential upside from the housing replacement echo boom as we assume some of this has already come through in key southern regions. However, if units truly are lasting longer, this could indicate that most of the upside seen over the past several years has been almost entirely driven by the pent-up demand dynamic coming out of the recession, and the bulk of the housing echo boom upside would still be to come, likely extending the length of the cycle and leading to above-average growth out past 2021. While this is not our base case, qualitative indicators and general discussions with industry experts and OEMs indicate that there could be something to the idea that the upcycle may last longer than our base case.

Downside case: Market recouples fully to indicators

Even prior to the economic slump brought on by COVID-19, our thinking was that we are past the recovery stage and into the mid-to-late cycle for residential HVAC. The pandemic has clearly influenced the industry but not as negatively as the indicators would have suggested. We are thinking LSD declines for 2021 but if actual replacement were to recouple to the index in a modest downside scenario, driven by a stalled recovery, the implied downside would be LDD %.

Figure 17: Overall Residential HVAC Market Continued Above Trend Line in 2020

units



Source: AHRI, and J.P. Morgan estimates

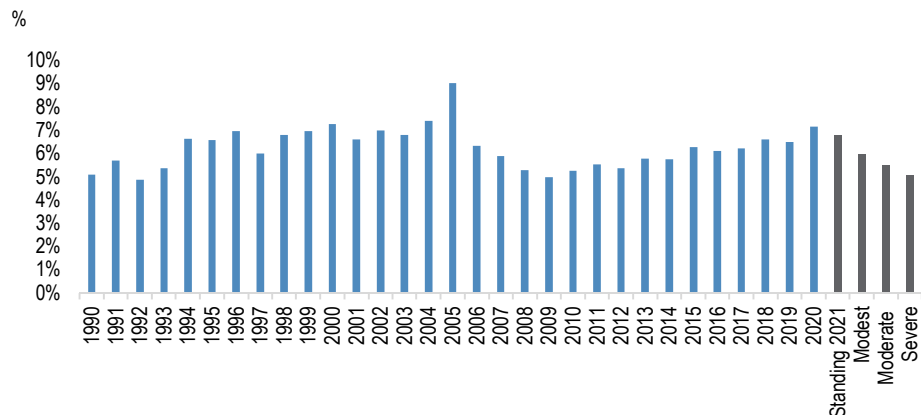
We present below a matrix of reasonable downside outcomes for each of these indicators, and plug into our model to determine an implied replacement rate in each scenario. Looking at the implied replacement rates in each scenario and comparing to prior cycles indicates that the "modest" downside scenario would represent a minor pullback, while a "moderate" scenario would represent more of a correction back to replacement levels seen earlier in the cycle when replacement was just beginning to recover. Our "severe" downside scenario doesn't quite get back to the ~5% replacement rate we saw at the depth of the downturn in 2009, which we think is probably a bit too draconian, but falls closer in line with still depressed levels seen from 2010-13. We think 2021 could be down ~LDD % in a modest downside scenario and MT % in a moderate downside case.

Table 12: Implied Replacement Rate at Various Downside Scenarios

Scenario	Consumer Confidence	Unemployment Rate	Existing Home Sales	JPM Index Predicted Replacement Rate
Standing JPMe	85	5.2	6.5	6.8%
Modest Downside	80	6.5	5.6	6.0%
Moderate Downside	75	7.3	5.2	5.5%
Severe Downside	70	8.0	4.8	5.1%

Source: J.P. Morgan estimates

Figure 18: Downside Scenario Replacement Rates vs. History



Source: J.P. Morgan estimates

OEMs do not believe there is a cycle or a down year in the cards

The OEMs are by and large brushing off concerns about a cycle. Carrier is noting a higher base off of a higher level of housing activity, Trane is now making the call that there is no longer a residential HVAC cycle. Lennox CEO Todd Bluedorn, the most exposed, noted a "bell-shaped curve for around 15 years and we're 15 sort of the midpoint. And we lay all that in, we think there's another couple of years of mid single-digit growth. And then after that there's going to be some point where what happened in '07, '08, '09 ripples through. And when we modeled, there's never a catastrophic year where the step function, there's a year where our model it's not a couple of points, but I think that -- that's within the margin of error of saying it's flat. So in that year if it's a hot summer, we're off to the races. There's also now additional forces and it's multivariable equation. You never quite account for, which is people are probably running their units a little bit longer because they're at home. There's probably going to be a bit more of household formation we get to other side of COVID because people are tired of living in their parents' homes and so they're going to go out there and buy homes".

Commercial HVAC Summary Views

US Commercial HVAC facing macro headwinds today...

We believe that the US equipment market dropped 11% in 2020, following 4-5% average annual growth in 2012-19, and included ~LSD % underlying construction declines, with significant replacement declines of ~MT %, with the unitary decline at a higher level than applied, which was helped by global exposure that held up. The overall commercial HVAC market is more dependent on the conditions of the macro backdrop and commercial construction than any industry-specific driver, and we expect moderate declines in '21 as the market remains depressed with the "new normal" hampering industries from hospitality, restaurants, travel, and retail. On the positive front, the long-term secular trend of shrinking square footage likely stabilizes depending on social distancing norms, and working from home may morph into more of a push for suburban locations, a counterbalance, and perhaps drive more middle market activity. Looking further ahead, there will be some spending as we move out of recession to reformat systems, whether security/access control to track and trace visitors or more IAQ products, though the opportunity here seems more incremental, unlikely to drive a big wave of investments, though an acceleration in ESG focus will likely enhance the building owners' awareness of the importance of top notch systems, and perhaps catalyze some replacements that have been due but were merely maintained. All in, we start with the view that non-res activity in the US will cycle as it has historically, based on the macro, with the declines seen in 2020 likely followed by another down year in 2021.

Table 13: JPM US Commercial HVAC Model

\$ billions	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E
Equipment (\$B)										
New	2.4	2.4	2.7	3.1	3.5	3.6	3.8	4.0	3.9	3.7
Replacement	5.1	5.3	5.4	5.5	5.5	5.9	6.2	6.4	5.4	5.9
Y/Y Growth										
New	7%	2%	11%	16%	11%	4%	5%	5%	-3%	-4%
Replacement	2%	4%	3%	0%	1%	6%	5%	3%	-16%	10%
Total equipment	4%	4%	5%	6%	5%	5%	5%	4%	-11%	4%
Equipment by type (\$B)										
Applied	3.2	3.2	3.3	3.5	3.6	3.7	3.8	4.0	3.6	3.6
Y/Y	1%	1%	2%	5%	3%	3%	3%	4%	-9%	-2%
Unitary	3.9	4.1	4.3	4.6	4.8	5.1	5.3	5.5	4.7	5.0
Y/Y	4%	4%	6%	5%	5%	6%	5%	3%	-15%	7%
Macro Assumptions										
New Non-Res Construction	7%	2%	11%	16%	11%	4%	5%	5%	-3%	-4%
% Chg Capacity Utilization	1%	0%	1%	0%	-1%	1%	2%	-1%	-7%	7%
% Chg Business Spending	11%	5%	7%	3%	-2%	3%	8%	2%	-5%	17%
% (Inc)/Dec in Vacancies	0%	1%	1%	1%	1%	1%	0%	2%	-3%	0%
Chg. Corporate Profits	10%	1%	5%	-3%	-2%	4%	6%	0%	-5%	19%

Source: J.P. Morgan estimates.

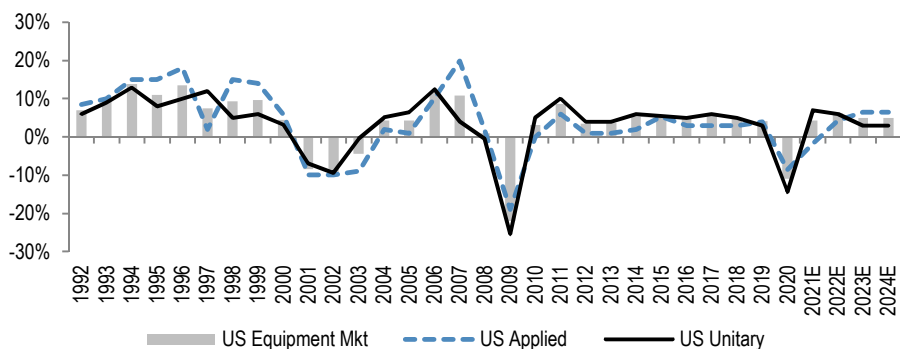
...and like prior cycles probably lingers...

The material changes around “getting clean” can be viewed as a blessing longer term but a curse near term. Indeed, CBRE recently noted through their interactions with occupier clients around return to work occupations that they believe on a weighted average basis, clients will go back to the office at ~85% of where they were before, with weighted average headcount down ~15%, but there remains a psychological overhang around decision making while in the midst of COVID. They noted that occupiers are going to want to have some remote capability as a more formal part of the portfolio with a focus on even more flex space in this coming cycle. They are still looking for guidance around design and solutions but there is currently a pause in the decision making meaning the cycle will remain a cycle, as occupiers need to have a clear understanding of how the footprint of their real estate needs will evolve over time which is not completely visible yet. In other words, we don’t see an immediate catalyst, as fragmentation of building standards, and a myriad of choices to get clean, many of which are cheaper than system replacements means this is less likely a dramatic wave in the immediate future, let alone low occupancy rates at present across offices and institutional buildings, as per the comments from CBRE management.

...but upside longer term on “new normal”, with aged applied markets coming due for upgrades

Despite the macro headwinds near term, for the first time since the last 1990s, we see outperformance in commercial markets versus residential for the next 5-10 years. The drivers are a global installed base that is aged with more customer attention on factors that should drive somewhat of an upgrade cycle. This is not only in the US but also in China, where the building stock will become officially aged from the 2000-2009 boom later this decade. We see US unitary as lower growth given headwinds in brick and mortar retail and strained local government budgets in education, along with less of an ESG push on installed base upgrades.

Figure 19: Historical and Forecasted Growth of US Commercial HVAC Equipment Market



Source: J.P. Morgan estimates, Company data.

Strategic Landscape: Pure-Plays Focusing On Technology Addressing Needs Of "New Normal," Not Consolidation

Structural portfolio breakout is most meaningful differentiator

Now that we have four publicly traded HVAC pure-plays, the stocks are getting lumped into a group and will be judged against each other. While we agree they should be judged against each other in a subsector, we think the most important thing to keep in mind is the breakout of the portfolios, as structure is the most important determinant of growth and margin potential, with varying degrees of both across these vastly different business models. Looking at the portfolio breakdowns below, we see that Carrier is the most diverse and has attributes of the other 3 peers, with most similarities to JCI with F&S exposure. Lennox and Trane are similar in that they are both heavily weighted HVAC, with no F&S and decent exposure to refrigeration.

Table 14: HVAC Portfolio Breakdowns

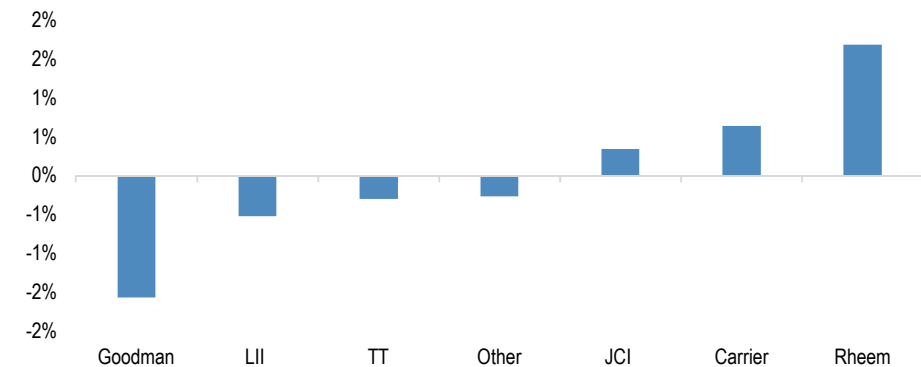
	Relative Mgn's	CARR	LII	JCI	TT
HVAC		51%	86%	55%	81%
Resi	20%+	21%	61%	3%	19%
Applied	LDD	12%	0%	17%	22%
Unitary	~20%	8%	25%	7%	11%
Service/Controls	LDD+	10%	0%	17%	28%
Other		0%	0%	12%	0%
Refrigeration		20%	14%	5%	19%
Transportation	20%+	13%	0%	0%	19%
Commercial	LSD-DD	7%	14%	5%	0%
Fire & Security	LDD	29%	0%	40%	0%

Source: J.P. Morgan estimates, Company data.

Residential: favorable structure proven out in price discipline, Goodman share recovery a watch item...

Following dramatic restructuring in the last downturn, and Daikin's purchase of Goodman, traditionally an industry disruptor, residential market structure remains favorable. This cycle has seen Lennox as a consistent share gainer early on, though Trane regaining prominence, with Goodman moving towards the high end and transitioning its manufacturing footprint, while Carrier likely lost a bit of share in the recent past, as did York, though Carrier, York, and privately held Rheem have appeared to be regaining share in recent periods. There was some upheaval in this trend in '20. However, with COVID-19 related complications hurting Goodman, who we estimate lost about 1.5% of market share, almost all of which went to Rheem, with Carrier taking a bit from LII/TT. More important than incremental out- and under-performance is that the pricing discipline has proven out to be positive, important given volatility around tariffs/raw material input costs. All of the players are reinvesting in their product lines to position themselves for the coming uptick in minimum efficiency along with the refrigerant changeover. Unlike the 10 to 13 SEER change, we don't see a major share shift as a result, something more like the 2015 experience, but note that Goodman is unlikely to stand down following a year of lost share, and there is risk that they disrupt.

Figure 20: 2020 Residential HVAC Market Share Shifts Using Public Data



Source: Company reports.

...outside of regulatory driven product refresh, ductless/hybrid an interesting product and something to watch

That said, for a market in which ductless/mini-splits were a niche product used mostly in targeted renovation applications, another step up in cost for ducted product with the coming regulations, could open the door for new “hybrid” solutions. Aside from the traditional unitary discussion, we see the potential for accelerated penetration of the residential mini-split “hybrid” products, traditionally a niche product for renovations and multi-family, with most of the recent growth around the commercial VRF. Here, while Carrier and Trane both have offerings, the most interesting product we have seen is the Daikin “Fit” line, a potential solution for the replacement market (~80% of industry volumes). This product, introduced in Fall 2019, offers inverter compressors with cabinet designs that are smaller, lighter, and quieter than traditional unitary outdoor condensing units, and can be installed using existing ductwork and line sets. It’s also easier to transport. Mini-splits are more efficient than ducted unitary products, with reportedly better performance, though the hurdle is that the first cost of the equipment is high and no one is going to rip out ductwork, making it expensive versus the baseline lowest SEER replacement unitary condensing unit. However, every regulation that raises the minimum efficiency level, and increases the cost of replacement for the traditional ducted unitary system, brings this equation closer to parity, an opening for players like Daikin/MitsubishiTrane JV, and a threat to the standard unitary “cube.” Daikin reps have noted that their Fit product is priced in line with a 16 SEER replacement today, and while we think this may not reflect as attractive of a margin for Daikin as the traditional unitary product, the corporate imperative to drive this technology suggests they may be willing to get aggressive in an effort to proliferate penetration.

Commercial product portfolios refreshed and ready to address “new normal”

The last 10 years has seen an increased focus on new products from commercial players on the back of coming/expected regulations around lower GWP refrigerants, with most of the innovation in applied/systems markets. Here, Trane has led the way, investing heavily in a combination of low GWP compliant equipment at higher efficiencies, along with controls/software and its service “feet on the street,” and they continue to take share, though they are not alone. JCI began to reinvest heavily with its new YZ platform in 2017, followed up by a methodical refresh of the applied portfolio, punctuated by the recently announced OpenBlue building management platform, all meant to leverage an already strong services footprint. JCI at AHR Expo 2020 continued to show fruits from their investments with new rooftop units as well as high tonnage (2,200 tons) chiller. Additionally, they have introduced 3 rooftop platforms in 3 years. This year there are 2 new platforms, the Choice (which was shown at the expo) and the Select platform. The catalyst for these new product innovations is the impending 2023 new efficiency standards from the DOE. That said, there is less innovation in more simplified commercial unitary systems, where targeting Carrier’s large installed base had been a beneficial strategy for Lennox over the years; however, both JCI and Daikin have been fast followers in recent years, and with Carrier now stand-alone, we doubt it will be as easy to pick off these sales in what we expect to be a more challenged market going forward.

Commercial services now a major topic, everyone talking attachment, degree of maturity and installed base opportunities vary

All of the major OEM players have talked about comm’l services recently, with a trend towards connectivity/digitization. On attachment rate, CARR talked about 30% at YE20 with a target of 50%, and JCI also cited a mid-30s rate, while TT called out 100% attachment on their applied systems for the past few years. On growth, CARR targets AM growth of ~10% in ’21, while longer term, LII targets ~12% growth through 2023.

Table 15: Recent Comments on Service/Attachment

Company	Notes
CARR	Started 2020 with 20% attachment in commercial HVAC and ended the year with 30% attachment, guiding to get to 50% in next few years. Less than 25% of commercial HVAC units are under some form of LTSA. Plan to get more units connected through some kind of edge device or some connectivity to increase attachment demand. Plan to get 10k additional chillers each year under LTSA starting in 2021 and believe that is one of the key drivers to say aftermarket growth is going to be ~10% in '21
JCI	When looking at service, the strategy before was to increase the installed base with the belief that you are entitled to service, and a lot of the service was mechanical in nature like breaks, and repair and maintenance. The strategy today is to embed technology in the installed base to connect everything and be able to leverage the data and be able to differentiate the types of services that can be performed. Attachment rate looks like they are undermined and underserved, and think they can improve it in the medium term. Attachment rate is different for both HVAC and F&S and is currently mid-30s right now. With strategy and technology under OpenBlue platform, they believe it can be enhanced significantly, targeting is 300-400bps growth expansion in '21 with run-rate continuing in '22.
TT	The attachment rate on their applied systems has been 100% for a few years. Globally, comm'l HVAC aftermarket (parts and service) is ~45%, up 10 points since the last downturn. In Americas, about half is service related, and this business works like clockwork when buildings are open so they expect good visibility, and growth in '21 partly driven by deferred services. Service is also about half of Europe and ~30% in Asia (growing rapidly vs in the teens range 5 years ago). They expect positive growth for service, driven by growing markets like data centers, warehouses, schools, healthcare, and in a big fragmented market with opportunity to consolidate and grow over time. They expect service to always outgrow equipment over the long run (~1-2% organic growth kicker). They are increasingly moving contracts towards performance contracts, as they like risk shifts and being paid to manage that risk with higher margins. The company cited an acceleration (by 3-5 years) in acceptance of digital technology to help deliver services remotely.
LII	In Comm'l HVAC, the company sees a rebound in planned industry replacements in 2021, and called for MSD growth or better. ~70% of Comm'l revenue is coming from planned or emergency replacement. It also sees improvement in NAS (National Account Services, 25% of Comm'l segment), where revs were expected at \$180 mm in 2020, down HSD y/y (and came in at down HSD in 4Q), and are seen at \$250 mm by 2023, growing at a ~12% CAGR. They have over 100 service branches across NA, providing self-performing service to >94% of NA customer sites, and have recently started to offer EMS monitoring and technical support for legacy EMS systems installed.

Source: Company data

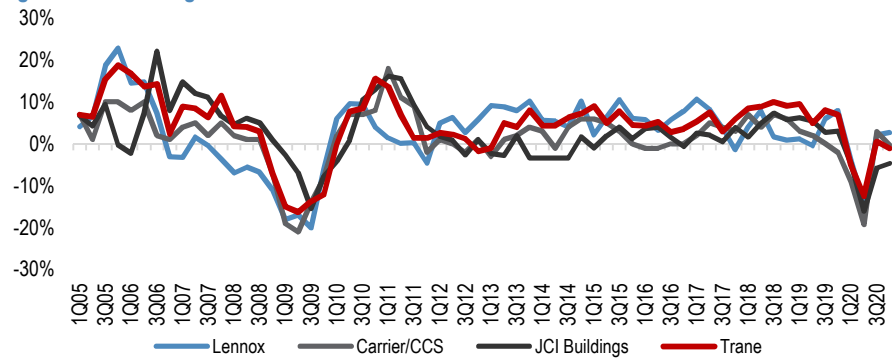
Commercial VRF continues to grow, but more a part of the portfolio of offerings but far from a “chiller killer”

Ductless products (mini-splits and VRF) continue their expansion into North America markets, but dynamics here appear to be relatively stable as each key OEM has partnered with an Asian player to enhance technology capabilities. Growth remains above average from a low base but is settling in more in the ~10% range versus the 20%+ rates a few years ago. With all the major US commercial players now positioned to participate in commercial VRF, it is unclear that there will be a dramatic “winner” here, though the combination of Trane and Mitsubishi is off to a strong start. The Mitsubishi Electric/Trane JV (METUS) is the exclusive provider of commercial VRF, which is effectively everything 3-phase, 6 tons and above, and for residential ductless 5 tons and below, single phase. On end markets, they see about 50/50 Resi/Comm'l (50% which includes some ductless). The JV had ~\$1 B revenue for FY19, representing ~21% growth versus FY18 with market growth ~12%. They were expecting another significant step up in growth in '20, and plan to invest to accommodate this growth and build inventory. Others are not standing still, with new commercial products at Carrier, while we have not heard much from LII/Midea.

Top-Line Fundamentals: Favorable, on Net, but Leadership Changing

Leading up to the COVID-19 outbreak, HVAC fundamentals had been in the midst of a golden era, with not only solid demand, but also with rational and stable supply with a consistent technology churn to allow for differentiation and strong competition, and players grew this cycle generally in the MSD range, with residential a bit higher and commercial a bit lower. Fundamentals are still favorable, but COVID-19 has reset the cycle from many angles. Last cycle was characterized by residential growth as a deficit of replacements/pent-up demand from the worst ever recession was released over many years, though now would appear to be at normal, and potentially even above normal despite COVID-19 headwinds. Commercial growth was subdued last cycle with customers focused on building productivity (i.e., doing more with less floor space), a continued hangover from the great 1990s commercial building boom, though with an aged installed base, and a shift in focus to IAQ from COVID-19 and carbon footprint from ESG could be catalysts for outperformance this cycle.

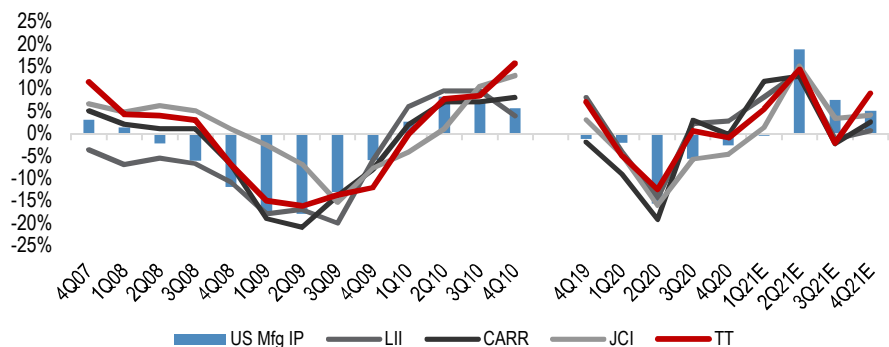
Figure 21: HVAC Organic Growth



Source: J.P. Morgan estimates, Company data.

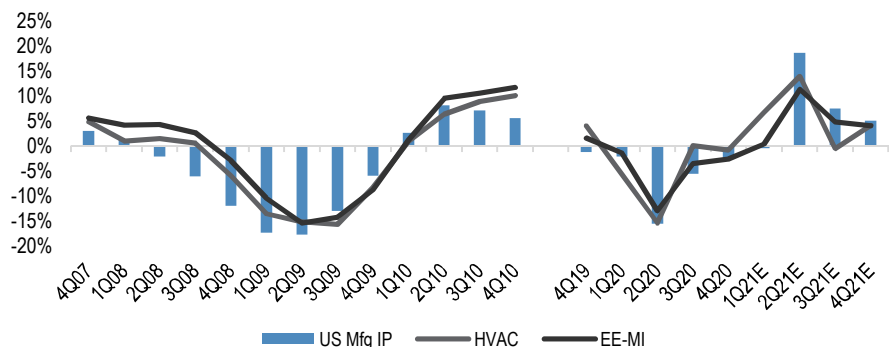
To provide some context, we show below at a high level how the major HVAC OEMs revenues tracked versus IP and the sector last cycle. This analysis of looking at the last cycle shows a more cyclical performance from HVAC names versus the group, with steeper declines than the sector average. On timing for this cycle, we see declines and recovery moving in lock-step with IP declines/recovery and the group at large, with organic declines bottoming in 2Q, along with IP declines. That said, we expect to see HVAC names outperform for a period as the economy v-shapes, and then normalize with the group, slightly different than last cycle where we saw continued underperformance even on recovery.

Figure 22: HVAC Peers Organic vs. IP y/y



Source: J.P. Morgan estimates, Company data. '21 estimates are illustrative, shape of trend could differ.

Figure 23: Average HVAC vs. EE/MI Sector Organic Growth



Source: J.P. Morgan estimates, Company data.

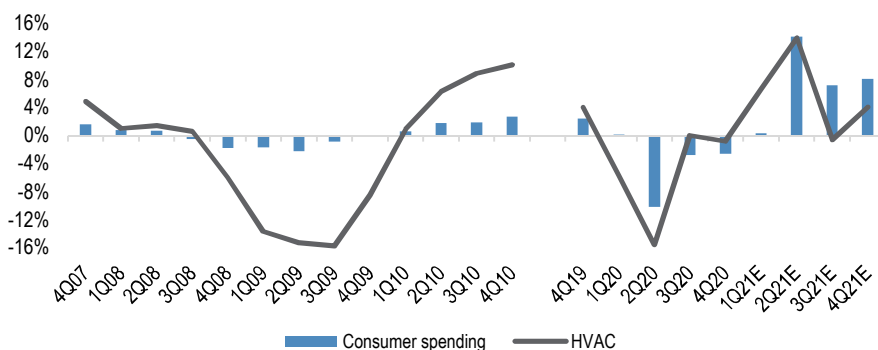
Assessing growth potential for HVAC companies during the uncertainty of the pandemic, the most important indicators for performance today involve construction, both residential and commercial. It is also important to take a look at consumer spending, which has rebounded quickly from the worst decline since the 1930's. This cycle we saw HVAC names dropping more in lock-step with the consumer spending declines, followed by a pick up as the downturn reversed, with the magnitude of decline and snap back likely to result in a saw-tooth outlook for 2021 as per the illustrative forecasts below.

Table 16: Quarterly Forecasts Relevant to HVAC

	1Q20	2Q20	3Q20	4Q20	1Q21E	2Q21E	3Q21E	4Q21E
Non-res Construction	6%	1%	-2%	-4%	-6%	-4%	-3%	-1%
Housing Starts	23%	-14%	11%	11%	8%	50%	14%	5%
Resi HVAC (AHRI)	5%	-10%	26%	36%	3%	20%	-14%	-20%

Source: J.P. Morgan estimates, Company data. Quarters are illustrative JPM EE/MI estimates.

Figure 24: HVAC Organic Growth vs. Consumer Spending



Source: J.P. Morgan estimates, Company data.

Recent results: Volatility continues into '21

Looking at the most recent results, overall, the results were above lowered expectations and management teams guided to continued momentum going into 2021. With resi ending 2020 with substantial growth across all OEMs, and a subsequently higher base than 2019 that was far from depressed, management teams guide to a more normalized 2021 for resi with growth in 1H and tough comps in 2H, with comm'l returning to growth in the 2H. This handoff between resi and comm'l is crucial for LSD/MSD growth OEMs are targeting given tough resi comps in the 2H and a key watch item for the year will be comm'l growth, which is tied to vaccine recovery and reopening trends.

Top line league tables: Subtle shifts – With all HVAC names having reported now, we estimate total HVAC company growth around 1-2% with Carrier at 4%, LII at 3%, TT flat, and JCI -4%, while Goodman grew 8% The numbers don't tell the whole story, however, as portfolio structure is more important in determining performance than head-to-head competition. For example, JCI lagged at -4% but this is entirely due to the fact 75% of their exposure is in commercial markets, where they were at the low end of the range in applied, though when it comes to residential they outperformed while light commercial performance was in line with the market. On the flip side, LII looks like a strong performer but lagged in its targeted markets. Trane performance was more in line with its peers versus prior periods, while Carrier showed outperformance for the first time since coming public, though the margin result was worst in class, a lingering question. The details by business line are in the table below. Notable is the growth in Daikin Americas ducted business, as it returned to growth following 3Q share loss driven by COVID-19-related outages that were picked up by others (we think Rheem). We also look at the full year results for the business segments to help smooth some of the variability period to period.

Table 17: 4Q Organic Top Line Results (y/y)

	Average	CARR	JCI	TT	LII	Daikin Americas	Notes
Resi	~+20%	+25%	+46%*	20+%	+LDD	+8%	
Captive/factory owned			n/a	+15%	+7%	-4%	Market up ~9% per HARDI
Independent		+20%	+46%	+25%	+25%	-	Market up ~30-35% for AHRI
Applied Comm'l	-MSD	+LSD	-MSD	-MSD	-	-	
Unitary Comm'l	-LDD	-10%	-LDD	-LDD	-13%	-	
Total HVAC	1-2%	4%	-4%	Flat	3%	-	
Transport Refrigeration	-LSD	-3%	-	-LSD	-	-	
Commercial Refrigeration	-LSD	+1%	-HSD	-	+3%	-	
Other (F&S)	-MSD	-5%	-HSD	-	-	-	
Total Company	-LSD	0%	-5%	-1%	3%	-1%	

Source: J.P. Morgan estimates, Company data.. *NA Only. **Ducted Only, ductless up 30-35% in 4Q.

Table 18: 3Q Organic Top Line Results (y/y)

	Avg	CARR	JCI	TT	LII	Daikin Americas	Notes
Residential	~+20%	+46%	+>30%	+High Teens	+13%	-13%**	Market up ~9% per HARDI, ~15-20% for AHRI
Applied Comm'l*	-LSD	-LSD	-MSD	+LSD	-	+3%	
Unitary Comm'l	-10-15%	-13%	-Low Teens	-Low Teens	-18%	-	
Total HVAC	4%	+11%	-3%	+4%	+4%		
Transportation Refrig	-10-15%	-10%	-	-15%	-	-	Broad Transport markets down ~25%+
Commercial Refrig	-MSD	-0%	-MSD	-	-12%	-	
Other (F&S)	-HSD	-7%	-HSD	-	-	-	
Total Company	-1%	+4%	-6%	+0.5%	2%	-6%	

Source: J.P. Morgan estimates, Company data. Includes BMS controls for JCI and related services for all companies. **Ducted only, ductless up 25-30% in 3Q.

Table 19: 2Q Organic Top Line Results (y/y)

	Avg	CARR	JCI	TT	LII	Daikin Americas	Notes
Residential	-9%	-13%	-MSD	-HSD	-6%	-7%**	Market down ~5% per HARDI, ~HSD/LDD for AHRI
Applied Comm'l	-14%	-low Teens	-Low DD	-MSD	-	-HSD	JCI is HSD for Field, and Low 20s through indep.
Unitary Comm'l	-21%	-low 20's	-mid 20's	-HSD	-28%	-	
Transportation Refrigeration	-34%	-28%	-	-40%	-	-	Broad Transport markets down ~40%
Commercial Refrigeration	-20%	-22%	-MSD	-	-27%	-	
Other (F&S)	-22%	-22%	-low 20's	-	-	-	
Total Company	-16%	-19%	-16%	-13%	-15%	-15%	

Source: J.P. Morgan estimates, Company data. **Ducted only, ductless up 25-30% in 3Q.

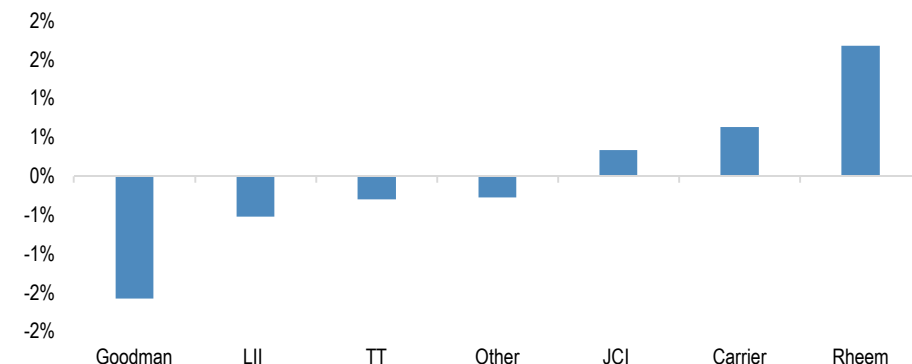
Table 20: CY20 Organic Top Line Results (y/y)

	Average	CARR	JCI	TT	LII
Resi	MSD	+10%	LSD	~+4-5%	3%
Applied Comm'l	-HSD	-9%	-Low Teens	-MSD	-
Unitary Comm'l	-Low Teens	-15%	-HSD	-MSD	-15%
Total HVAC	-LSD	-2%	-HSD	-1%	-2%
Transportation Refrigeration	-15-20%	-14%	-	~20%	-
Commercial Refrigeration	-HSD	-9%	-MSD	-	-13%
Other (F&S)	-HSD	-9%	-HSD	-	-
Total Company	-5%	-6%	-6%	-5%	-4%

Source: J.P. Morgan estimates, Company data.

Residential industry quick look. For residential specifically, the order was JCI, CARR, TT, LII, then Goodman. Once again, there was a big difference in “sell in” to distribution and “sell through” distribution this quarter, which influences these results and explains part of the bifurcation (CARR is almost all independent distribution) as the season played out. Commentary all pointed to a continuation of strength into 1H21 as CARR highlighted backlog is up almost threefold compared to a year ago, and TT highlighted strong bookings going into '21.

Figure 25: 2020 Market Share Shifts Using Public Data



Source: Company reports.

Industry Margins: Up Over Time, Some Step Back in '20, But Far From a Collapse, Highlighting Favorable Structure

The margin algorithm for the industry is to produce incremental margins around the level of gross margins (30%), driven by a combination of volume leverage and price/cost, with investments funded for the most part by ongoing productivity initiatives. In the table below we show the high level construct in its basic form, though this can obviously vary from year to year depending on things like volume growth and material cost inflation.

Table 21: HVAC Company Margin Dynamics

Index=100

Profit bridge	Revs	Profits
Starting	100.0	14.0
Organic	4.5	2.1
<i>Volume</i>	3.5	1.1
<i>Price</i>	1.0	1.0
Materials	0.0	(0.6)
Inorganic	0.0	0.0
FX	0.0	0.0
Other	0.0	(0.1)
<i>Investments</i>	0.0	(0.3)
<i>Productivity</i>	0.0	0.3
Ending	105.0	15.5
Margin bridge		
Starting		14.0%
Volume		0.5%
Price/cost		0.2%
Investments		-0.3%
<u>Productivity</u>		<u>0.3%</u>
Ending		14.8%
<i>Incrementals</i>		30%

Source: J.P. Morgan.

Coming out of the recession, the HVAC industry was generally aggressive in taking out cost and capacity to effectively compete in a world with lower volumes. Volumes have since returned, and margins have improved solidly almost across the board and are now back above prior peak levels. Positive price/cost trends have helped, along with company specific supply chain initiatives and better operations, as well as aggressive restructuring at many key players. With price/cost now fading to about neutral, we see less margin expansion going forward, but averages should continue to be able to move gradually higher absent any volume or commodities shocks. This year has shown that margins are somewhat resilient compared with the GFC but still down on volume pressure.

Table 22: Historical Operating Margins of Major HVAC Players

% segment operating margin as reported (may not be comparable)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Trane	n/a	11.3%	9.9%	5.6%	7.7%	8.4%	9.0%	10.4%	12.1%	12.7%	14.5%	14.1%	14.3%	14.6%	14.6%
LII Commercial	9.7%	11.5%	11.2%	8.3%	11.2%	11.3%	12.7%	14.0%	14.1%	14.7%	16.3%	16.2%	17.5%	17.5%	17.1%
LII Resi	11.4%	10.4%	9.8%	8.6%	11.0%	7.0%	7.5%	11.4%	13.6%	14.9%	17.4%	17.5%	16.7%*	17.0%*	18.1%
Carrier ¹	8.4%	8.9%	8.7%	7.3%	9.9%	11.7%	14.2%	15.4%	16.5%	17.6%	17.5%	16.4%	15.8%	14.5%	13.7%
CARR standalone, HVAC only												18.3%	17.9%	17.2%	15.1%
CARR, HVAC + Refrigeration												17.4%	16.8%	16.2%	14.1%
Goodman ²	10.1%	11.7%	7.5%	14.9%	16.2%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
JCI NA Systems + Service ³	7.8%	9.6%	10.2%	10.0%	7.6%	7.9%	9.9%	11.3%	10.5%	11.9%	11.9%	12.9%	12.4%	n/a	n/a
Avg	9.5%	10.6%	9.6%	9.1%	10.6%	9.3%	10.7%	12.5%	13.4%	14.6%	15.5%	15.8%	16.1%*	15.9%	15.9%

Source: Company data, J.P. Morgan analyst estimates. Note: *LII Resi 2018/2019 excludes insurance recoveries. 2018 average is ex-JCI.

(1) Prior Carrier reporting segment that includes Transicold and commercial refrigeration; segment discontinued in 2012 and now included in CCS segment while part of UTX (CCS margins from 2013 onwards)

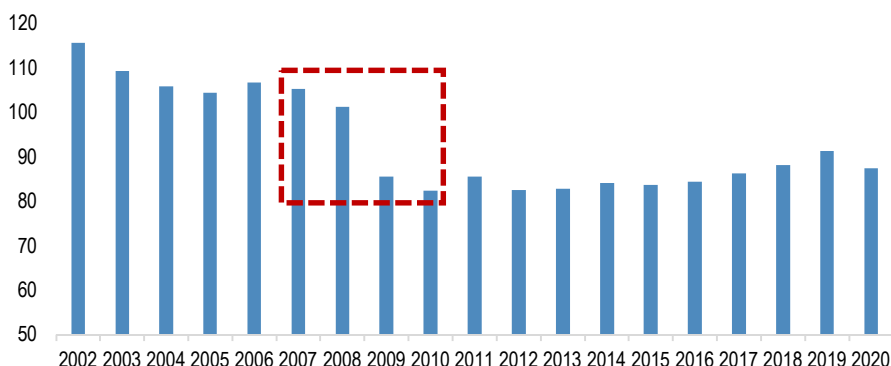
(2) Based on public filings through 3Q10 (2010 number is a trailing 12mo margin number); includes all allocated corporate

(3) Includes all allocated corporate

The industry spent much in restructuring last decade, as total employment in the HVAC industry (as measured by the Census NAICS category) declined ~18% from its most recent peak in 2007 to 2010, and has since remained in the same range. As background, we profile below the major restructuring programs seen at three of the “Big Five” HVAC OEMs: Carrier, Lennox, Trane, and JCI. Goodman was less pronounced in terms of restructuring as the company gained share through the downturn, though it still did flex down employee headcount in response to demand, while they recently brought up production on their new facility, which is fully automated with the ability to double output over time, beneficial for their margins but the added capacity a risk in a future of potentially lower volumes.

Figure 26: US Census Bureau Data Show HVACR Employment Down 18% from 2007 to 2010

Employees (in thousands)



Source: US Census.

JCI the standout performer in 2020

With the onset of COVID-19, restructuring efforts were renewed, with all major HVAC players focusing on short term relief through headcount reduction, furloughs, salary cuts, and discretionary costs, managing decremental margins well despite significant volume declines. Like in other industries, the degree of structural versus temporary costs is a key driver as we look ahead, though most are guiding for standard incremental margins on the way back up, evidence that there is a lot of temporary cost out, and that investments are necessary to keep pace in an increasingly dynamic and competitive industry. The average decremental margin for calendar 2Q (the trough) was ~25% for the sector, while for the year we saw ~35% (note this excludes restructuring) and for CY21 we expect 26%. The best decremental margin story last year came from JCI, with the company seeing HSD decremental margin for 2020. The other HVAC names in our coverage were all over the map. TT stood out positively (13% decremental), and CARR on the negative side (45% decremental). LII had the worst reported decremental for the year (75%), but this would be ~3% adjusted for insurance benefits in 2019 results (\$99mm total), a solid result. Below we show decremental margin performance in the trough sales quarter (2Q) and for CY20 on the whole, as well as updated expectations for CY21 based on shifting and accelerated cost take out schedules.

Table 23: 2Q/CY20 and CY21E Decremental/Incremental EBIT Margins

	2Q20 (trough sales)	CY20	CY21E
CARR	34%	45%	25%
JCI	9%	8%	21%
TT	23%	13%	27%
LII	31%	75%*	30%
Average	24%	35%	26%

Source: J.P. Morgan estimates, Company data.

Table 24: Company Cost Action Guides

	2020 Total	Temporary	Structural
CARR	\$500mm	\$250mm	\$250mm (CARR 700)
JCI	\$500mm	\$400mm	\$100mm
TT	\$100mm	not disclosed	\$100mm
LII	\$40mm	\$40mm	-

Source: J.P. Morgan estimates, Company data.

JCI – The company executed well on planned cost mitigation, with best in class decremental margins. On the specific cost action, the company saw a total of \$500mm for the year, with \$300mm done in F3Q and the remaining \$200mm completed in F4Q. \$100mm of this is structural in nature, with \$400mm temporary with varying degrees coming back in 2021 based on topline performance. The \$400 of temporary cost mitigation is broken down into \$245mm from compensation, \$125mm of indirect spending, and \$30mm of facility costs. We expect a total of ~\$290mm headwind in 2021 with the majority of the temporary cost coming back, especially in compensation, while facility and indirect spending are more dependent on top line growth. In 2020, we saw the total \$500mm of cost savings impacting EPS by \$0.49 and in 2021 we see the total of \$18mm tailwind from the \$250mm tailwind from permanent action, \$60mm of SG&A savings and the -\$292mm of temporary cost headwind resulting in a \$0.02 tailwind to 2021 EPS.

Trane - Looking at Trane, the company posted decremental margins of 13% for the year, with the expectation to do ~30% incrementals in '21 (around their gross margin, and above their long term algorithm of 25%). On cost actions to mitigate COVID-19 headwinds, the company realized ~\$100mm of cost reduction in 2020, and an additional \$40mm of savings in 2021 with a 2021 run rate of ~\$140 mm. The \$100mm of cost savings is made up of \$70mm within the businesses and \$30mm in corporate. The company also mentioned costs on the year, such as factory under absorption, and that the action taken in 2020 was mostly seen as a way of offsetting this cost, with some additional discretionary items such as travel that may or may not come back in 2021. Management noted that it is difficult to determine how much of the 2020 cost savings come back in 2021, and that much of it is top line dependent, although it is likely that not more than 50-60% comes back. Beyond this, the company has highlighted a plan to reposition IT and supply chain to deliver an additional \$160 mm in savings by 2023 one-third of which will be realized in '21.

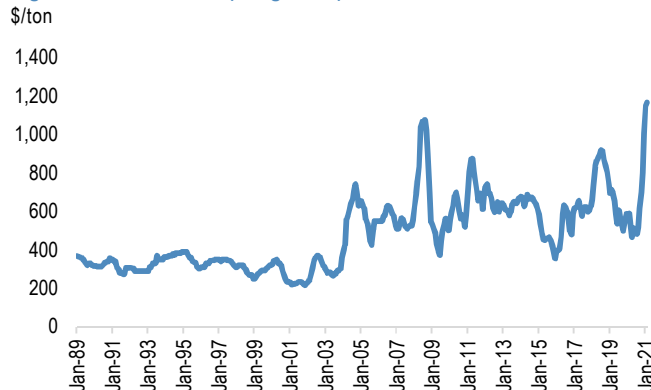
CARR - Next, looking at CARR, where the main story is surrounding the Carrier 700 plan for \$700mm of structural cost take out through 2022, the company saw decremental margins of 34% in 2Q, but with a weak 4Q the year ended up around 45%, below expectations. For '21, the company guided to ~30% incrementals, which is about where we expect the year to end up. Here, on cost actions to mitigate COVID-19 headwinds, the previously announced Carrier 600 cost out schedule has been accelerated, and is now dubbed Carrier 700, and the company realized ~\$250mm of 2020 cost action from Carrier 700 (prior \$225mm), with an additional ~\$200mm from temporary mitigating actions such as salary cuts, travel reduction, headcount, with a ~\$100mm headwind from investment activity, which they have increased from the previously expected \$75mm due to improving market conditions. This brings the total cost action to ~\$350mm for 2020. In 2021, they expect the Carrier 700 program to bring \$225mm in cost savings, \$125mm in 2020 COVID-19 factory disruption tailwinds, \$150mm in investments, and a reversal of the \$200mm in 2020 temp cost actions.

LII - For Lennox, decremental margin performance was solid adjusting for the insurance benefit in the base year 2019, with 3% for 2020. The company said 2020 SG&A cost savings were targeted at \$55mm, impacting 2Q-4Q, and for the full year SG&A ended up declining \$30mm, of which savings ended up being a \$40mm benefit. The company implemented the cost reduction May 1st starting with salary reductions. Additionally, the company noted that the degree that this cost comes back is dependent on top line and volume performance in 2021, and standing guidance includes a \$45mm headwind from SG&A in 2021.

Price/cost a risk factor in 2021

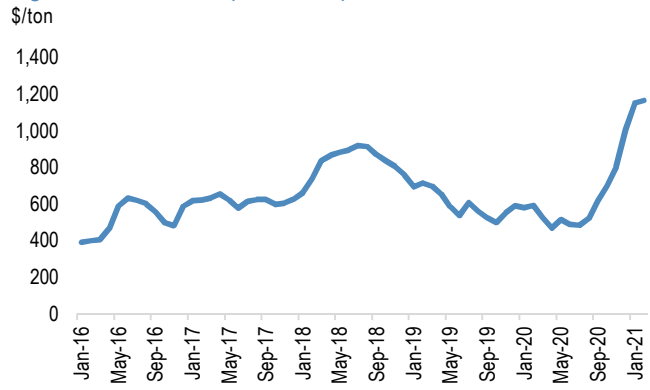
After a period of commodity deflation, steel and copper picked back up in the latter half of 2020 and remain high currently. OEMs have largely offset inflation effects with price increases in the past (i.e., a distributor could show an HVAC customer the chart on copper if it got pushback of price), but typically with some lag so if commodities shoot up rapidly, there may be a brief period of squeeze. For 2021, CARR guided to neutral price/cost with 75% of 2021 requirements locked or blocked. TT guided towards positive price/cost in '21 with 20-30bps of price over cost with copper locked 50% and steel purchase lead times of 6 months. LII guided towards positive price/cost with copper and aluminum hedged, however steel creating a headwind, while JCI reiterated a positive spread for FY21.

Figure 27: Steel Prices (Long-Term)



Source: Bloomberg Finance L.P.

Figure 28: Steel Prices (Short-Term)



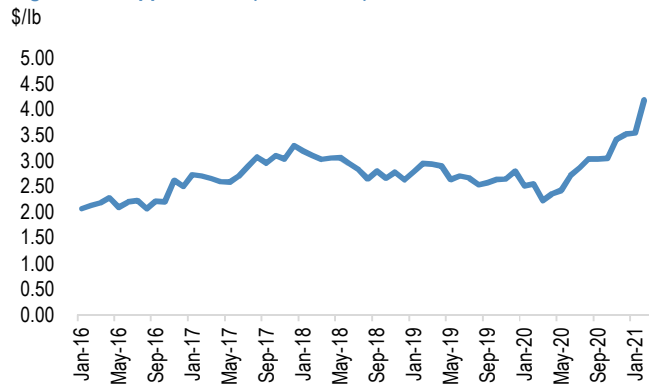
Source: Bloomberg Finance L.P.

Figure 29: Copper Prices (Long-Term)



Source: Bloomberg Finance L.P.

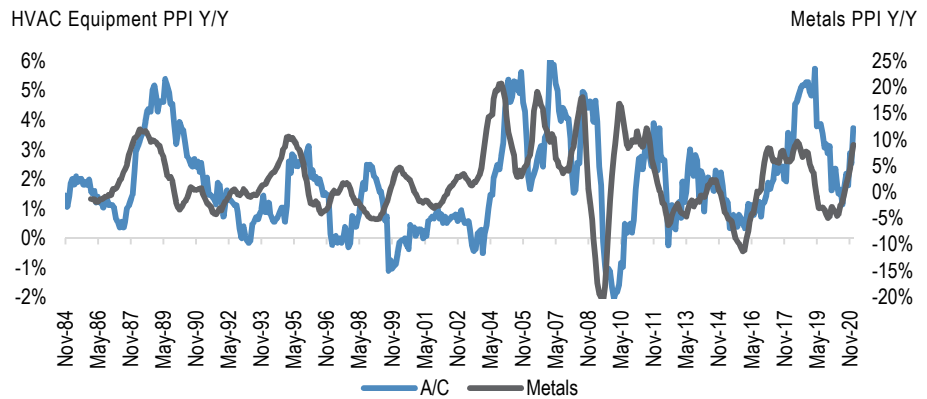
Figure 30: Copper Prices (Short-Term)



Source: Bloomberg Finance L.P.

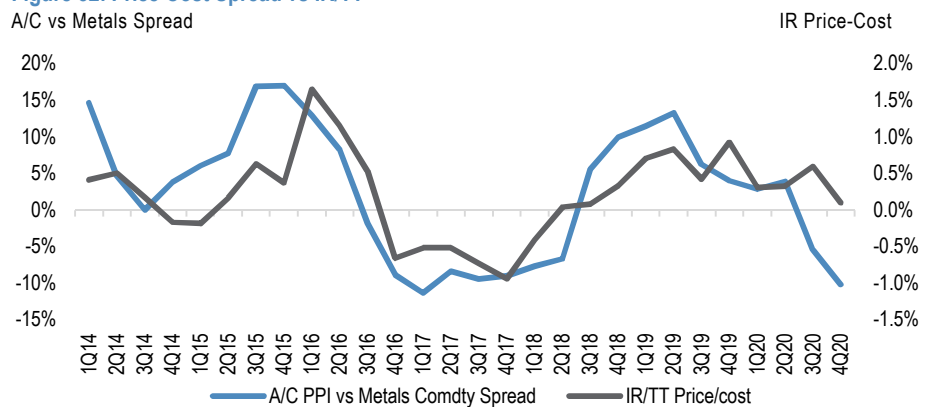
While industry price discipline is a historically proven positive attribute in resi HVAC, the risk is that in periods of rapid inflation, like 2010, the OEMs will have to temporarily absorb a negative price/cost spread that may not necessarily be made up in the following year. As shown in the charts below, there tends to be a lag of as much as a year between metals inflation and HVAC pricing. On the positive side, however, HVAC OEMs typically don't give back pricing during deflationary periods, meaning they can recoup some of this margin; this happened in 2009 as well as during 2012-15. The price/cost spread at OEMs would generally trend with but lag behind the moves in these indicators.

Figure 31: A/C PPI vs. Metals PPI



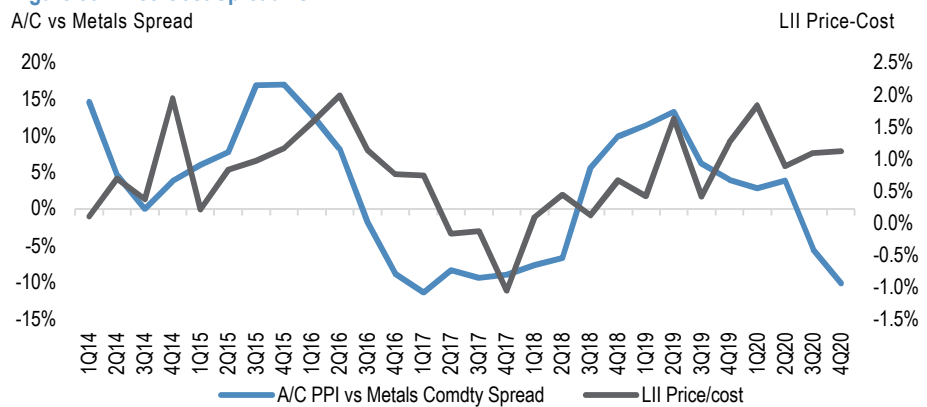
Source: BLS.

Figure 32: Price-Cost Spread vs IR/TT



Source: BLS, Company reports

Figure 33: Price-Cost Spread vs LII



Source: BLS, Company reports

Strategic Overviews

There are several commonalities to the strategies here. First, most OEMs have accelerated new product development in recent years to refresh their portfolios. Other commonalities include increased investment in technology, ecommerce and controls, though strategies differ somewhat among the key players when it comes to their approach to distribution, especially in residential. Lastly, each one is noting a deliberate approach to VRF, but from different angles. Keep in mind that when talking to the undisputed leaders, Daikin and Mitsubishi, each of the majors is considered a significant laggard. Trane's partnership with Mitsubishi through METUS JV has given them a leg up in this regard.

Trane emerges as best-in-class franchise

A key driver of the story here has been a complete refresh of the Trane portfolio. In 2017, ~85% of revenue came from products introduced since 2012, and in 2019 they began to reap the benefits of these new product launches. When Trane was acquired by IR it had <20 new product innovations in the pipeline. Today the company has more the 200. This type of vitality has made its way into HVAC. First, on resi, as per the raw data, Trane's resi HVAC business has emerged as best-in class with above industry growth rates over the last 3 years. For the residential business, management said at their Investor Day in May 2017 that 80%+ of revenues were from products introduced over the previous 36 months. Here, the portfolio is as broad as they come with the XV20i high efficiency 18-20 SEER, with a variable speed compressor, to the value end Ameristar offering targeted at the non-owner occupied or rental market. They recently introduced the new "Ox Box," which is a line of affordable residential HVAC equipment for single and multi-family homes. They also offer a side discharge product for zero lot line meant for MF and smaller lots like California. Indeed, this portfolio is all part of an increased focus on penetrating the new construction markets which is just ~15% (vs 85% for replacement) of their sales versus an industry average that is higher. Trane is also differentiating with digital solutions and services which includes their Trane/ASD 360 app for B2B customers, along and the Trane GO platform which provides more information on the options available for the consumer, along with pricing estimates for equipment and installation. They are also using technology to improve their own logistics and distribution, particularly in NA Resi. This was rolled out in all metro markets, and includes details on price ranges for products, installation costs and a Q&A for consumers to understand what they actually need. Overall, the old IR said it expected ~\$300mm in incremental revenue from their new strategies from 2017-2020 which has seemingly played out into COVID-19.

On the commercial side, 20% of products were renewed each year from 2014-2016. The company launched EcoWise across the enterprise, a portfolio of product choices with lower GWP refrigerants, where they saw themselves as first to market with products that are both environmentally friendly and efficient. They also emphasized the importance of staying ahead of the curve on technology and refrigerant regulations, and they are able to work with different refrigerants, and launched their new furnace platform where they improved efficiency and took 20% costs out. Most recently they are highlighting the Sintesis chiller, a fully electric unit that combines heating and cooling, eliminating the need for a separate fossil powered boiler. Another key differentiator of focus is their \$1B services and controls platform which combined with their broad equipment portfolio, provides a wholesome customer solution and service capability. They see 90% of total cost of ownership over a 30-year life of equipment as coming from services, and cited near 100% attachment rate on new sales, with 8 times more profitability over the lifecycle compared to original equipment. Trane's service staff in the US doubled to 2,600 in 2017 (5,000 globally, 1,000 in China) since its acquisition by Ingersoll, making them the largest HVAC services force in the industry, with 30% growth in HVAC service agreements and 200% growth in rental services revenue in 2012-2017. They also have ~1,000 sales engineers globally, with 500 in China, and are putting emphasis on a direct and technical salesforce and focused distribution. Across compressor technology and commercial HVAC, the company cited two-thirds linkage to equipment in 2018. Geographically, China is at two-thirds service take rate in commercial applied vs 20% five years before (where they hired 350 new account managers/salespeople), while Western Europe and NA are close to 80%+. They also saw a 25% controls linkage to their service agreements in 2014-2017, off of a controls platform that was #1 as per Navigant in 2017 vs no position in the top #10 3-4 years before. They have ~23,000 connected buildings in their installed base and were adding 50-100 a week thanks to their integrated equipment + controls + service product breadth and strategy. From 2017-2020, they expected their services and controls platform to add ~\$400mm in incremental revenue. Lastly, on VRF, they started their VRF business in NA in 2014, which grew at a ~45% CAGR to 2018 (vs industry at 15%) and they believe they are #1 in VRF in NA. Growth has moderated now in the \$750-800mm NA market, but they believe they will continue to grow faster than the market. They expect ducted to accelerate in Asia, while ductless will accelerate in Western economies. With the METUS JV, they're able provide their NA channel to offer the Mitsubishi ductless products and can combine them with the right applications in their portfolio. Trane saw VRF as a ~\$200mm incremental revenue opportunity from 2017-2020, driven by both market growth and share gains 5x the market. The premise here was to bring their ~10% share in 2017 in VRF to the standing 30% share in light unitary, again, leveraging an already strong market position.

At an investor day in December the company highlighted how its M&A decisions the last few years helped fuel innovation and lead to new product offerings. Between 2016-2019 they had 22 acquisitions totaling ~\$2B. For example, the 2017 acquisition of Thermocold helped become a basis for their 4-pipe chiller. Artic Chiller was another acquisition where it helped them learn a significant amount about magnetic bearing compressors. Overall management views M&A as a way to expand their operating map and fuel innovation across the pipeline in terms of new product offerings.

Trane also introduced a plan to reposition IT infrastructure and supply chain over the next 3 years to save ~\$160mm. On the IT front it will be deployed closer to the customer with direct accountability to the business. For example, they have worked through the IT portfolio to reduce overlaps in aging applications by 40% and will reinvest these savings back into front-end systems to help teams work and reduce the risk of obsolescence. On the supply chain, Trane targets to drive productivity across 70 plus spend categories to drive cycle reduction and increase throughput.

The company also reiterated its plan to be a sustainability leader and pure-play climate innovator. They instituted the gigaton challenge to reduce 1 billion metric tons of CO2 emissions for their customers by 2030, which is equivalent to 2% of the world's annual emissions. They see 2 accelerating megatrends that are relevant for their long-term strategy, the first being IAQ and second digital connectedness. Digital connectedness is becoming increasingly important as they can remotely fix and adjust building systems versus sending technicians in person. Also, they are capturing building data from over 21,000 connected buildings to understand how buildings are being used like occupant patterns and flows, which gives them the ability to make real-time changes to save energy or improve the health and comfort of the building.

Table 25: Summary of Trane's Strategic Initiatives

Initiative	Notes
Residential	
New products	80% vitality index from 18-20 SEER variable speed product to Ameristar/Oxbox value product, to side discharge product for targeted geographies
Distribution strategy	Steady state, distribution is 50/50 owned/indirect distribution
Increase new construction penetration	There is an increased focus on penetrating the new construction markets which is just ~15% (vs 85% for replacement) of Trane's sales (50/50 in China and newer economies). This has already been a key driver of growth for them over the last few years and they see more room to expand here. Note Resi sells ~50% of products through company owned distribution while the ASD brand is ~100% independent.
Digital capabilities	Launched the Trane 360 and ASD 360 app for B2B customers to automate and quicken turnaround order/delivery of new equipment and parts. Also, launched Trane Go for consumers, where they can look into installation cost and equipment price points online and in a more transparent manner with ease of scheduling installation and delivery online – early results have shown success in adoption and conversion. They are also using technology to improve their logistics and distribution, particularly in NA Resi. They are targeting \$300mm in incremental revenue growth from 2017-2020 from digital initiatives in resi HVAC.
Commercial	
New products	Trane has been active in introducing new products. They launched the EcoWise portfolio across the enterprise. All their products have gas capability for low environmental impact, with high efficiency and safety for the last products launched. The development process here was lengthy, and Trane is keeping the efficiency benefits while guaranteeing the low environmental impact, as 85% of chiller operation cost is energy. There are 3 European countries where you can't use the old refrigerant, and this is a key share gain opportunity, with a new combined heating and cooling product that helped to create a \$1 B market opportunity in Europe. The Sintesis chiller is a fully electric unit that combines heating and cooling, eliminating the need for a separate fossil powered boiler.
Services and salesforce	In total cost of ownership over a 30-year life of equipment, 90% comes from services and near 100% attachment rate on new sales, with 8 times more profitability over the lifecycle compared to OE. The company has made large investments for a more direct and technical salesforce, particularly in China where they hired 350 new sales engineers and are training them quickly. They're seeing about 2/3rds linkage in China, vs NA/West Europe at 80%+.
VRF strategy	They are targeting ~\$200mm incremental revenue growth from 2017-2020, and saw 45% CAGR from 2014-2018 and believe they're #1 in VRF in NA, and expect to continue to grow faster than the market. With the Mitsubishi JV, they're able provide their NA channel to offer the Mitsubishi ductless products and can combine them with the right applications in their portfolio.
Connected buildings	They have ~23,000 connected buildings in their installed base and were adding 50-100 a week, thanks to their integrated equipment + controls + service product breadth and strategy. From 2017-2020, the saw their services and controls platform adding ~\$400mm in incremental revenue.
General	
M&A	They have made smaller bolt-ons for technologies, aligned with trends such as electrification of heating in Europe, thermal storage, and services, and will continue to do so.

Source: J.P. Morgan

Lennox steady as she goes, end market leverage more of a driver

Management has pitched a revenue growth algorithm is market + a half a point of share that's worth 3 points of revenue to us, a point of price, point of mix, which gets them to 7-9% growth rates, even in a low single-digit market growth environment. This is something that has been done over the past decade, but we see as more challenging given the cycle has matured and there is incrementally more focused competition. The key strategic differentiator for Lennox over the past decade has been aggressive investment in its company-owned distribution channels, though they had paused a bit with the tragic tornado event and the onset of COVID-19. The company has dramatically increased its distribution footprint through expanding PartsPlus stores and has also regionalized its distribution strategy to improve same or next day delivery capabilities. Because of a tornado and pandemic, there's been a couple of years it hasn't built any. It is opening up 30 new stores in 2021. These stores are three people, two are front, one in the back, about 25,000 square foot. They get to operational breakeven in a year and at the end of two, three years, they are \$2.5-3 million of revenue, about half incremental, meant to serve customers, dealer contractors who with a 30-minute driving radius of the store. They will open 30 new stores next year, 13.5% of the current 222 base, with 350+ the target for 2025 (a ~9.5% CAGR). With the current 220 stores, they believe they are covering about a third of the market, so could go as high as 600. Somewhat related, they are looking to grow parts & supplies sales (currently \$385 mm) at a ~15% CAGR from 2020 to reach ~\$700 mm in 2024, with profitability similar to the new equipment business.

On Resi digitization, it will continue to invest and believes its user experience is better than peers, with a focus on making dealers more productive and profitable through services like Repair Parts Finder, PDP, and Tech Experience on LennoxPROs. On the technology side, they have built out the DaveNet dealer portal, which we think stands as one of the best online platforms supporting contractors. They also believe they are in early innings on diagnostics/prognostic capabilities, which will be a differentiator going forward. All of these initiatives are aimed at driving outperformance by converting dealers. The company had performed well relative to the market, with strong outperformance earlier in the cycle as we think they picked up share from Trane, which underperformed coming out of the R-22 transition in 2011, but Trane has since become the biggest share gainer recently while Lennox is still outperforming the market but by a lesser magnitude.

New products are expected to support share gains, including the launch of a 28 seer for Resi (SL 28cv), and the Model L comm'l rooftop, the most energy efficient product in market, with variable speed and new controls including premium diagnostics features to provide lowest TCO, and a built-in IAQ package. On this front, it said it has a bit less than \$100 mm of revs in IAQ, but touted an "industry leading offering," including Pure Air S, which removes over 90% of the virus that causes COVID-19, UV lights, humidity control, and outdoor air exchanges / ventilation, as well as Building Better Air initiatives to help building owners with IAQ surveys and with tailored solutions. According to management, however, only 25% of new replacement systems have attachment of IAQ-related products, and with 50% of the industry at entry level that represents somewhat of a ceiling.

They continue to see opportunities to expand margins, benefiting from incremental engineering and sourcing savings of \$25mm (currently half of components are sourced outside NA, which it will continue to optimize with expansion into South Asia, while costs are being designed out of products like variable speed drive technology) and factory productivity of \$20mm (includes a new factory in Mexico). On the latter, the company notes that 50% of units are made in Mexico, but just 40% of production hours were there, and this will be up to 50% with the new plant (moving indoor coil production from Mississippi to Mexico). This project is worth ~20c to EPS over 2021/2022. Additionally it continues to make automation investments to drive down conversion costs, where for instance it is using Siemens software to help automate application engineering for engineered to order products in Refrigeration to improve lead times and quality of bill of materials. It believes it's in the 3rd or 4th inning of automation, with only 1/3 of manufacturing associated with fabrication where it's penetrated, leaving significant opportunity in the rest of the factory (assembly and test).

Table 26: Summary of Lennox Strategic Initiatives

Initiative	Notes
Digitization	The company has talked about digitization investments. ~40% of their Resi sales are online and they target ~50% by 2023, which is being helped by the onset of COVID-19. On customers' use of its sales tools, they counted 3.3mm site visits in 2018, and 3.6mm for its technical tools.
Market Share	After regaining ~80% of share back from Tornado, LII is now switching focus to gaining market share elsewhere in different channels, not only winning back customers they had lost.
Residential	
Expand distribution footprint	Company has aggressively expanded PartsPlus stores, while increasing same-day/next-day delivery and higher margin parts sales. Lennox's physical distribution footprint grew by almost 300% since 2010, with 222 locations in NA expected to grow to 252 in 2021. As background, the average store is ~10K square feet, with 80% dedicated to warehouse and 20% a front-end wholesale store. 84% of sales are equipment and accessories, while 16% are parts and supplies. While the rollout was suspended with the tornado and COVID-19, they target 350+ stores in 2025 by rolling 20-25 new stores per year. According to the company, these stores break even after 12 months and usually reach the \$4mm sales mark after year two. Lennox thinks their focus on increasing wholesale distribution points is enabling them to get access to smaller dealers who don't want to carry inventory and want access to spare parts. They also focus on driving same-store sales at existing stores, and growing their NA HVAC Parts and Supplies revenue from \$385mm in 2020 (24% of total rev) to ~\$700mm in 2024 at a ~15% CAGR.
New product line-up	As the 2023 efficiency regs near, they are launching a 28 seer for Resi (SL 28cv). The company has also made improvements in recent years, on its entry level Merit Series where they've added utility rebate-qualifying furnaces and air conditioners, and enhanced corrosion resistance of heat pumps.
Regain share post-tornado	Lennox is in the process of regaining back the share it lost due to the tornado impacts on its Marshalltown facility.
Commercial	
Diversify commercial national account exposure	National accounts make up half of NA revs and have traditionally been focused on the retail vertical, but Lennox is diversifying and winning new business in hospitality, entertainment, restaurant, distribution centers and medical verticals.
Capture share in emergency replacement	They've entered this market, traditionally dominated by Carrier through new product intros like the Raider, which sits on top of existing Carrier platforms. They've expanded distribution to support same-day delivery, where the company has gone from 20% same-day in 2010 to >90%. The company has gained market share here over the past several years. They continue to invest in distribution, training and parts to grow share with local and regional contractors, not only for emergency replacement but also for construction and planned replacement.
New product introduction	They are launching the Model L comm'l rooftop, the most energy efficient product in market, with variable speed and new controls including premium diagnostics features to provide lowest TCO, and a built-in IAQ package.
Refrigeration	
Refrigerant transition	LII developed a full CO2 product line over the last year to serve food retail/service industries as they move to LGWP refrigerants.
Productivity	They introduced the first parts of their next-generation selection and application software, a platform to reduce lead times and improve the quotation and equipment selection process. They piloted an engineering automation tool Rulestream, and nearly achieved a lights-out engineering process for unique orders according to the company. They are implementing this on their newest designs and expect productivity improvements.
Streamline NA operations	In an effort to improve service level and distribution transportation productivity, they are looking at their supply chain and identifying areas where they can reduce spend and improve customer response. Their NA Heatcraft business opened a new distribution facility adjacent to their factory. They will review their network models for outbound delivery to identify transportation savings opportunities.

Source: J.P. Morgan

Carrier pushes on extra cost saves, while re-engaging on key investments in 4Q20/2021

While the big part of the CARR story had been cost savings, the company has been putting forth a steady stream of new products recently. Management was pleased with their performance in 2020, however note there is room for improvement. They want to reduce the G&A profile of the company longer term as well as simplify operations by reducing real estate holdings, number of legal entities and ERP systems. With ~35% of sales coming from Services and Aftermarket and 65% from new products, there has been some commentary from management that they are looking to bolster their services business especially given the increased scrutiny surrounding IAQ. They ended 2020 with a 30% attachment rate in comm'l HVAC and guided to get to 50% in the next few years with the goal to add 10k additional chillers each year to LTSA.

On refrigerant regulations, Carrier was the first to commit to Chemours' R-454B refrigerant for unitary products, as its primary lower-GWP solution to replace R-410A in all of its ducted residential and light commercial packaged solutions sold in North America, in response to the 2023 deadline around R-410A (now pushed out). The new refrigerant (which will be marketed under the name Puron Advance) will be offered in Carrier products beginning in 2023, and is expected to surpass the requirements of anticipated future regulations. The R-454B has a GWP of 466, one-fifth of the R-410A, minimizing environmental impact and energy use, while also offering improved performance, safety and longevity. This commitment is for ducted equipment in residential and light commercial, but Carrier will maintain its optionality for other types of equipment as it will select the best-suited refrigerant for other applications as the need arises.

Within IAQ, Carrier introduced new products like the OptiClean and is looking at incremental add-ons to its existing products. The OptiClean system can roll into any room and plug into a standard electrical outlet to quickly improve IAQ in schools, dental offices, hospitals and other commercial facilities. It can be operated in 2 modes: (1) **Air scrubber** - which uses 99.97% efficient, long-life HEPA filters to remove particles as small as 0.3 microns and discharge clean air back into the room and (2) **Negative air machine** - which helps convert normal hospital rooms into negative-pressure airborne infectious isolation rooms (AIIR) by adding a vacuum effect to the HEPA filtration capability. Within incremental add-ons to existing products, Carrier is looking at add better filtration systems or UV lights.

One of the biggest highlights from the newly formed Carrier has been the focus on permanent cost take out attributed to being a leaner stand-alone pure-play HVAC company. The company is focusing on cost take out primarily through supply chain improvement, but also through factory efficiency as well as general and administrative costs. The "Carrier 600" cost take out strategy plan for \$600mm of structural cost take out through 2022 has been accelerated due to COVID-19, and upped to the "Carrier 700." The company realized ~\$250mm of 2020 cost action from Carrier 700 (prior \$225mm), with the ultimate goal of \$700mm through 2022. Additionally in 2020, the company took out ~\$200mm from temporary mitigating actions such as salary cuts, travel reduction, headcount, with a ~\$100mm headwind from investment activity, which they have increased from the previously expected \$75mm due to improving market conditions, but is still below the initially planned \$150mm for 2020. This brings the total cost action to ~\$350mm for the year. Looking a bit longer term, management outlined medium term (2-3 year) expectations at their March investment day, with total company sales expected to be up MSD, EPS up HSD, and FCF to be in 90-100% conversion rate.

Table 27: Summary of Carrier Strategic Initiatives

Initiative	Notes
General	
Multi-brand strategy	Their multi-brand strategy with scale allows them to compete at an entry level price point well. Payne is the value brand, Bryant is mid-tier positioning, ICP is a mid-level brand, and Carrier is the high-end premium brand.
Standalone Carrier	As a stand-alone entity, Carrier will evaluate M&A actions and will go forward focusing on products and services, and not on installation and field. Additionally the CARR 600 permanent cost take out is spurred on by seeking efficiency as a stand-alone.
Refrigerants	Carrier committed to Chemours' R-454B refrigerant for unitary products. The new refrigerant will be offered in Carrier products beginning in 2023, and is expected to surpass the requirements of anticipated future regulations. This commitment is for ducted equipment in residential and light commercial, but Carrier will maintain its optionality for other types of equipment as it will select the best-suited refrigerant for other applications as the need arises.
Residential	
Divested distribution	Carrier has made an aggressive push to divest the majority of its North American distribution assets and become more heavily focused on strictly the OEM side of the business. Specifically, the company has already divested a significant piece of its company-owned locations through its JV with Watsco, Carrier Enterprises, to which it contributed 95 locations. In addition, the company sold three additional geographic regions into the WSO JV, all in a similar 60/40 arrangement. Carrier also formed another JV with its company-operated residential and light commercial distribution in California, combining its operations with Russell Sigler, Inc. Since formation of the Carrier Enterprise JV, Watsco has increased its ownership stake in the JV to 80%.
Minority investments	Somewhat underappreciated, UTX has a number of minority investments in CCS that they don't consolidate, worth about \$6B and primarily in resi and light comml HVAC, as well as distribution. Among these is a strategic partnership with Ecobee, which was named the #1 smart thermostat by Navigant two years ago. Carrier also has its Cor home automation platform.
Capture share in multi-family	Company has traditionally been strong in single family construction, but making a push in multi-family, which is sold through different channels like MRO suppliers to property management companies, landlords, etc. They focus on distribution/product in single family and strategic partnerships in multi-family, with different brands at different price points to meet specific customer needs.
Commercial	
Products: focus on applied	Carrier believes they have #1 share in NA light commercial, but have fallen behind in applied. In response to that, they're focusing investments in applied and have invested across the board on products and service, with a focus on developing a complete product line, local and immediate availability, first cost, effective local distribution, with mechanical contractors and strategic accounts sales, which has translated into a significantly higher product vitality index compared to a few years ago. Carrier also said that it's defending its installed base in Commercial against LIL's Raider brand, with several new types of equipment. They have realized they need to have a full portfolio of air side products as well, a business they have deemphasized for some time, and they feel they have some work to do here.
VRF	They believe they've tripled their market share in ductless over the past 4 years and are solidly in DD territory. As a stand-alone entity, they will also have more flexibility to invest in a VRF in-house solution, a missing piece of their portfolio as they currently partner with Toshiba and Midea for VRF.
Digital/controls	10% of revs are digital/software based, while another 65% is systems with smart controls or embedded software.

Source: J.P. Morgan

JCI product portfolio refresh continues

The main strategy for JCI remains owning the integrated building by offering an integrated solution with both controls and systems. HVAC is a key buildings system, and JCI's commercial exposure is more focused on large applied applications, which makes sense given the integrated value proposition makes more sense for larger institutional verticals. JCI's HVAC business was slower growth last cycle, with residential and commercial unitary well below scale and underperforming the market on quality issues, though growth has been strong off a low base the past few quarters as the company has invested in new products. Commercial applied has also mostly lagged over the cycle.

The introduction of the recent OpenBlue system, which houses all of their remote services technology, IAQ products and services, and interconnected cloud tech, is an exclamation point on these investments. The OpenBlue system takes all the data that is consumed in a building, puts it all in a single dashboard and uses machine learning and AI to create outcomes that customers have historically targeted within buildings to reduce energy use and improve inefficiencies. OpenBlue creates an optimized building that not only helps reduce energy costs but also optimizes clean air delivery for healthier air flow. Strategically management sees this as transforming a typical transactional HVAC sale to a strategic sale and partnership with customers going forward. The idea behind OpenBlue, in addition to drawing attention to JCI's IAQ and energy efficiency capabilities, is to have a clear and simple system that can be applied uniformly to new contracts. Instead of building customized solutions for every new contract, OpenBlue standardizes the options for the customer and allows for easier selling and marketing points for the company as well. Management remains optimistic regarding the OpenBlue system attachment rate for services. Companywide the attachment rate for services varies between 25-60%, averaging 35%, and they believe they can increase the attach rate for services by 3-4% per year as it moves across the installed base. Furthermore, with service margin twice the company average, management views the OpenBlue platform as an attractive driver to increase future profitability. They have over 27 solutions in this offering to serve an addressable market that they size to \$10B-\$15B, and JCI believes it will grow DD CAGR over the next 5 years. OpenBlue allows customers to cut building energy consumption by up to 50%. Furthermore they also announced 75% of their new product development dollars will go towards tackling climate change.

More on the product side, at last year's AHR Expo, JCI impressed with new product offerings, with a scaled down new 14 SEER entry level heat pump, optimized indoor units to make the outdoor with a smaller footprint for AOR. The York LX Series is an ultra-low NOx gas furnace, which won an innovation award. It's the same footprint as prior models but because of new materials, it is 2x the price. For VRF, Pacific Northwest is pushing this type of product. The majority of buildings are hybrid and use various solutions for different applications and the company expects to see more hybrid solutions over time. They have introduced 3 rooftop platforms in 3 years. This year there are 2 new platforms, the Choice (which was shown at the expo) and the Select platform. The catalyst for these new product innovations is the impending 2023 new efficiency standards from the DOE. Choice can be replaced without a traction curb to replace Carrier and Trane. The Select product will be able to go after Trane's installed base. Efficiency is measured in IEER, and in 2023 it will be set depending on size. This new equipment is above those new standards, and competitor equipment is not there yet. York optimized with the right components with multi-stage compressors to get to part load performance. Trane Voyager 2 and 3 are the targets, while Carrier is the Weathermaker lines. Premier product introduced last year was aimed at Carrier curb on smaller tonnage. Danfoss and Copeland are

used as compressor suppliers, Danfoss at higher tonnage. Every product has a smart equipment controller. The company gave an update on Verasys, saying it is not into the hundreds of millions yet most of the dollar value content is driven by pull-through. On chillers, the new Yz expanded capacity from 1,425 tons on a single compressor design to 2,020 tons on a dual compressor design, called the Yz2020, with redundancy on the compressor a key value add. This high capacity YZ model features improved energy efficiency vs. previous designs in this capacity range of centrifugal chillers.

JCI executed well on cost savings actions in 2020 with \$100mm of structural savings and \$400mm of temporary cost savings. Additionally, they instituted a SG&A cost reduction plan to reduce SG&A costs by \$300mm on a run rate basis by FY23, with \$60mm starting in '21. \$180mm of these savings are from Shared Services and Footprint rationalization including COE consolidation and centralizing product management while the remaining \$120mm deals with external spend items like reduced travel and centralization and optimization of functions. Management is also guiding to release a COGS cost savings plan later in 2021.

Table 28: Summary of JCI Strategic Initiatives

Initiative	Notes
Residential	
New UPG products	After years of share loss and questions around the core nature of the resi and light commercial business, York has refreshed its product lines and is starting to gain back some ground. At the 2017 AHR Expo, the company showcased new 20 SEER systems, their Affinity line, a follow up to the 16 SEER product from last year, and rounds out a complete refresh of the resi line that started a few years back. Reviews on the new product lineup were positive from the distributors we talked to, highlighting the wireless/tablet enabled simplified diagnostics onboard panel as an attractive feature for contractors. Much like the 16 SEER which uses a 5-stage Mitsubishi compressor, the new 20 SEER uses a Copeland inverter compressor, but they plan to eventually use a Hitachi compressor and be fully variable by 2017. We heard from distributors that York is actively embarking on building out company owned distribution for resi/light commercial unitary in selective markets where they have lost share.
Commercial	
Products	York has traditionally been focused on the high end of chiller products for large applications, as it is targeting large institutional verticals for integrated buildings. We had heard anecdotes through the channel that the high end of share has been targeted by Trane, Daikin, and Carrier over the last few years. JCI recently released its new flagship centrifugal chiller for the high end, the YZ. They believe the product is well beyond a catchup of competitor products, and expect to grow a bit above a chiller market which they see growing 4-5% per year, though competitors argue the technology is more of a catch up, a key TBD going forward.
OpenBlue	Announced in 2Q20, the OpenBlue system houses all of JCI's remote monitoring technology, IAQ and SEER focused equipment and services. This system standardizes JCI's offerings, allowing customers to easily upgrade or initiate total system installs with a longer service tail.
Building controls	Metasys is the key building controls platform for the JCI integrated buildings strategy, a more custom and closed system architecture that works best as part of an integrated solution with other JCI systems. We have noted in the past that open architectures seem to be growing faster across most applications, and JCI released its Verasys controls platform which is targeted at the middle market/unitary product control, a natural evolution from the high end markets targeted by Metasys. The key here is simplification and more plug and play configuration. Including equipment, they believe this allows them to more effectively target what they view as an \$8.6B market that is currently dominated by Trane and Carrier.

Source: J.P. Morgan

Goodman's new facility ramp up stalled by COVID-19, buying in some distribution

Goodman has historically earned its top share position around dominating the large value space with what many in the chain referred to as "cheap air", with share gain events around regulatory changes. Now, the company is focused on repositioning a more broadly applied brand portfolio, with more of a traditional good/better/best approach, and seemingly prioritizing margin over market share at this stage, highlighted by a new mega facility in Houston consolidating several local facilities with the potential for 2x the standing output in residential units. They have doubled the number of SKUs so things are more complex, which is why this factory is necessary. This initiative has been far from smooth, however, with some teething issues around the robotics/automation, and last year COVID-19 related shut-downs put them out of the game for a solid part of the season, leading to share loss.

On the product side, Daikin is focused on moving up the Good/Better/Best chain with higher priced/efficiency units under the new Daikin brand. They are also promoting the hybrid ductless product, the new "Fit" line. This product requires less condenser coil surface area, allowing for smaller cabinet sizes and doing away with the traditional large, wrap-around condenser coils, while also being more efficient through its variable-speed swing inverter compressor that ramps up/down based on need, saving money and energy during non-peak load periods. Importantly, the product is smaller, allowing customers to free up space and contractors to fit more equipment on fleet vehicles, and is also more versatile, combining the features and performance of ductless-style condensing units with the ability to connect to traditional ducted systems. The Fit line is available in 1.5- to 5-ton capacities and is compatible with Daikin's line of communicating gas furnaces. The product is similar cost because Daikin sets the price internally to allow for the same price as competitive 16 SEER products. SEER regulatory increase may accelerate acceptance of these ducted mini-splits. Still a hurdle for the contractors to install however. On the penetration of inverter compressors, it is growing but remains 2-3% of overall volumes, well short of initial targets set in and around the merger date, though it believes there are others like LG and Panasonic that are looking to sell into the US, but differences in SEER ratings by regions can limit the potential for mass adoption. Part of the strategy above is in residential and here the company has been buying up some distribution recently with three deals. These have expanded the captive base of about 200 locations by about 10%, with the majority of the activity around controlling the channel to market for the Daikin brand.

In refrigerants, Daikin is sticking with R32, which is fine for distributors, but not ideal for the dealers. If you have a Daikin branded dealer and they carry a second brand, they will need two additional refrigerants (R22, R410A, R32 and then others). Goodman will go to R32 as well. There will be some churn in the dealer alignment because of this dynamic as depending on how things are done, if the sensors sense something, the blower on the furnace needs to be turned on, and this is a challenge for mixed systems, which means the whole system may have to swapped out.

On commercial, Daikin in 2020 had several new products and is an up and coming competitor here. First, a new rooftop unit up to 17 SEER, 5-year warranty versus 1-year standard with heat exchanger a 20-year warranty versus standard 10, the 3- and 5-ton unit is designed to fit the Carrier curb, a savings of ~\$6 for the customer, which is meaningful. There was also the new Aptitude oil bearing chiller, 1,500 tons works with new 12333zd refrigerant, and smallest footprint, the first new platform of which scale in 10 years and will launch up and down the spectrum of size from 700 tons to 2,000 over the next several years. They also launched the Magnitude magnetic bearing chiller, the first of its kind in 6 or so years, and going up against the York Yz (Carrier uses ceramic components). Lastly, the Rebel applied rooftop packaged system for hospitals/K-12, designed to fit the Trane high end IntelliPak curb at 30-52 tons, costing ~\$50K, a bit cheaper than the competition with a low leak cabinet a key feature. They plan on launching models up to 140 tons.

Unlike many others, Daikin is more exposed globally, and is a more diverse HVAC supplier, given customer preferences for air conditioners vary according to country and region because of different climates and housing styles. For this reason, Daikin has developed products that meet the local needs of customers around the world. Overall Daikin is confident in their close market proximity model, which allows them to build systems quickly in the local markets they operate to go to market faster. Also, with the expansion of the air conditioning market, particularly in emerging markets, there is a shortage of service engineers involved in field work. The company aims to develop and train service engineers to tap into this shortage and improve global aftermarket service sales. Daikin has a renewed focus on growing service revenues post-COVID-19. They realize that recurring service revenue is a competitive advantage in tough times where they can improve going forward. While service revenues were challenged going into the pandemic, Daikin now expects service to grow in 2020. Over the longer term, Daikin sees major tailwinds from environmental policy changes in Europe. In Europe they plan to grow sales for residential and commercial use utilizing environmental technology as they work to achieve expansion of heat pump systems. In France, they are experiencing strong sales due to a subsidy to phase out combustion type systems to more energy efficient heat pumps. Daikin also reiterated the strong performance of IAQ with air quality and ventilation products sales this year to be 160% year on year. Sales of residential air purifiers are expected to grow significantly by 205% year on year and they will begin production in Malaysia. Priority areas for R&D are CO2 reduction, energy conservation, and Safety and security

CO2 reduction: With air-conditioning demand expected to accompany economic growth in emerging countries, they view this as perpetuating the climate crisis. Initiatives are accelerating among countries to set medium- to long-term reduction targets for CO2 emissions (more than 120 countries are declared a target to reach net zero CO2 emissions by 2050). Daikin plans to contribute here by the development of low GWP refrigerants and promote technology development involving recovery and recycling of refrigerant. Further, Daikin plans to expand the heat pump market globally to trend away from combustion-type equipment. They want to promote conversion of heat pump heating in colder regions and have made improvements in heating capacity and efficiency for low outdoor air temperatures.

Energy conservation: With the proliferation of renewable energy in the coming decades, Daikin believes technological development is needed energy management for air conditioners. Here they want to gather data from AC units and share that data to power providers so they can understand power demand and manage load better.

Safety and security: Needs for safety and security in air quality are growing worldwide and Daikin plans to invest R&D spend in streamer UV, filters and ventilation equipment.

Table 29: Summary of Goodman/Daikin Strategic Initiatives

Initiative	Notes
Factory integration	The company encountered COVID-19 related issue at the new Houston megaplant and lost share in 2020.
Brand restructure	The company is focusing on evolving its brand portfolio. The company is focused on repositioning a more broadly applied brand portfolio, with more of a traditional good/better/best approach, and seemingly prioritizing margin over market share at this stage.
Commercial refresh	New rooftop unit up to 17 SEER with heat exchanger, new Aptitude oil bearing chiller (1,500 tons), launched magnitude magnetic bearing chiller to go up against the York YZ. New Rebel applied rooftop packaged systems for hospitals/education.

Source: J.P. Morgan.

Rheem and up and comer

Rheem makes HVAC (#5), water heaters (#1 or #2) and some refrigeration products, and the company is larger than Lennox in size and presumably similar to Lennox and AO Smith in profitability. They are owned by private Japanese consumer products company Paloma. Rheem globally is more than 50% water heating, while Rheem Americas is approximately evenly split between HVAC and water heating. Rheem sales mix tends to skew more heavily to Residential relative to its competition, but they have and continue to make significant investments in Commercial HVAC and water heating. Since the great recession, Rheem has invested almost \$1B to completely refresh their residential and light commercial product lines, expand their manufacturing capabilities, and introduce new technology platforms and systems across its business segments. For example, they have already made investments in a highly automated factory in Arkansas for light commercial unitary products. On this front, they have a new platform, with remaining models launched this year, around which contractors participated in the design, with the main features better serviceability and the industry standard footprint, the Carrier “curb” which can cost an extra couple thousand for the contractor to fit and mirroring strategies seen at others. They are also investing heavily in brand new residential platform ahead of the 2023 regulations. They have partnered with Fujitsu and they have a hybrid launched. They have also completed several acquisitions to expand their product range and geographical reach. They are 100% independent distribution in US HVAC, with Watsco and Ferguson being their largest channel partners. The Home Depot is their largest channel partner in water heating. We have been hearing more positive things from the marketplace on Rheem for some time, and are impressed with the strategy/execution and recent degree of portfolio refresh here. They have been growing significantly over the past several years and have increased their market share positions in almost all business segments. They view their water heating expertise as a differentiator as they are the only major player with products that integrate air and water. Judging by their footprint which is almost 100% in Mexico, we assume that profitability here is amongst best in class.

Stock Positioning and Relative Valuations

Looking ahead, HVAC fundamentals are mixed in the near term, with flat performance in 2020, as residential surprisingly grew and commercial was down in line with macro fundamentals. We see a change in end market leadership, however, with commercial accelerating off of the industry bottom while residential moves into more of a volatile flat environment following a 10+ year super cycle off of the '08/'09 bottom.

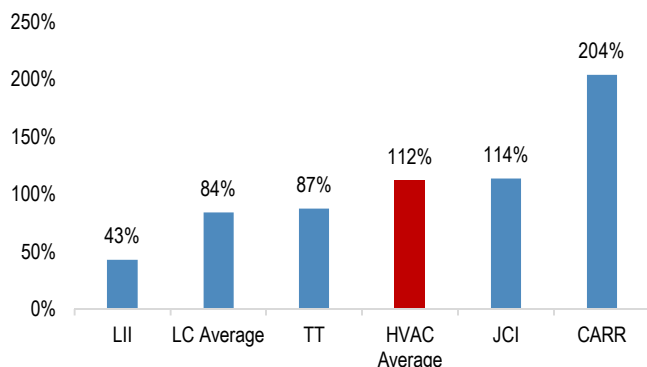
Table 30: HVAC Company Financial Performance

	2019	2020	2021E	2022E
<u>Organic sales, y/y % change</u>				
CARR	1%	-6%	6%	6%
TT	7%	-5%	6%	5%
JCI	5%	-6%	4%	4%
LII	3%	-4%	5%	5%
HVAC Average	4%	-5%	5%	5%
EE/MI sector x-GE	3%	-5%	5%	5%
<u>Operating Margins</u>				
CARR	14.8%	12.8%	13.6%	14.5%
TT	13.2%	13.2%	14.2%	15.0%
JCI	10.4%	10.6%	11.4%	12.1%
LII	16.2%	13.9%	14.7%	15.2%
HVAC Average	13.6%	12.6%	13.5%	14.2%
EE/MI sector x-GE	17.5%	16.8%	17.6%	18.3%
<u>Operating profits, y/y % change</u>				
CARR	1%	-19%	15%	13%
TT	11%	-5%	17%	10%
JCI	9%	-5%	12%	10%
LII	12%	-17%	11%	8%
HVAC Average	8%	-11%	14%	10%

Source: Company reports, and J.P. Morgan estimates

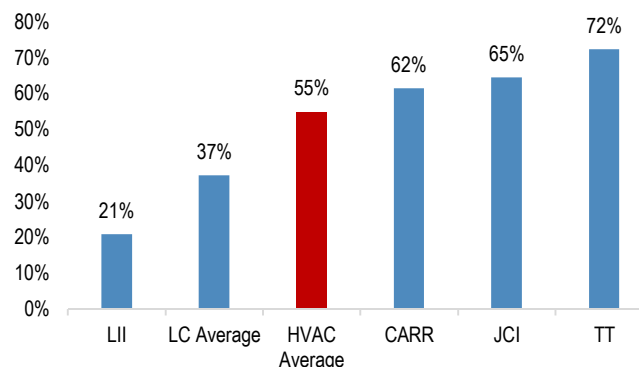
On the stocks, investors have taken a more positive view thematically in certain HVAC stocks, but on average the '22 P/E of 21x is in line with our sector, which moves to a ~0-5% discount on EV/EBITDA. Since the four publicly traded players were established (CARR spin), the HVAC sector on average has seen ~2,500bps outperformance versus the EE/MI Sector, with ~10.5x multiple expansion versus the sector at ~9-9.5x (ex-GE/DHR). Since beginning of July, HVAC stocks have outperformed the group by ~1,800bps, while their multiples have expanded by ~5x vs EE/MI ~3.5-4x.

Figure 34: Stock Price Change Since CARR Spin



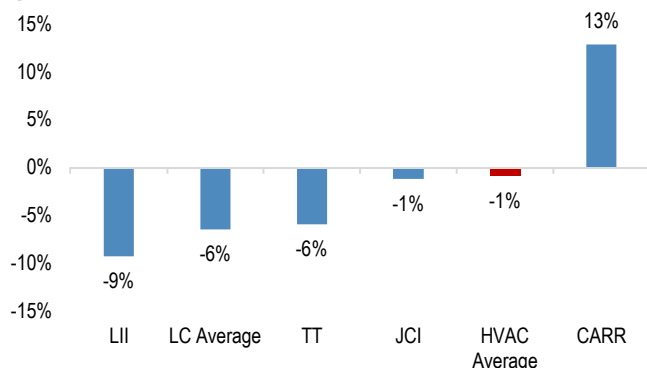
Source: Bloomberg Finance L.P.

Figure 35: Stock Price Change Since July



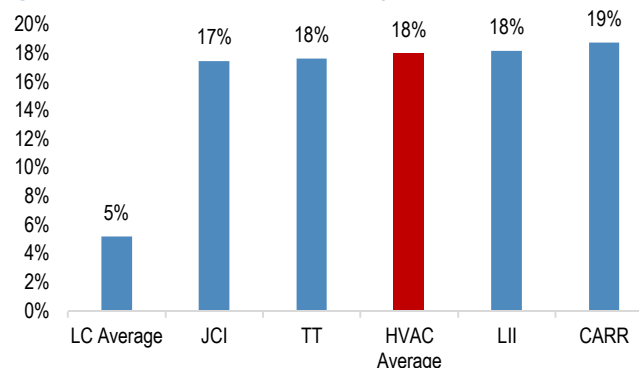
Source: Bloomberg Finance L.P.

Figure 36: FY22 EPS Revisions Since CARR Spin



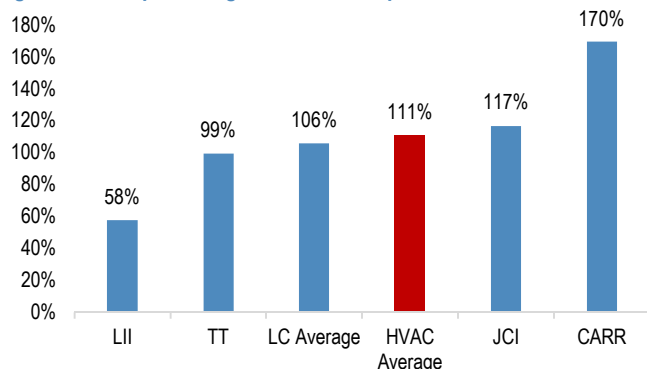
Source: Bloomberg Finance L.P.

Figure 37: FY22 EPS Revisions Since July



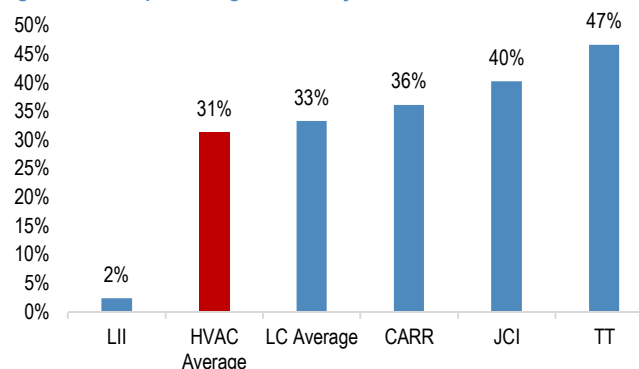
Source: Bloomberg Finance L.P.

Figure 38: Multiple Change Since CARR Spin



Source: Bloomberg Finance L.P.

Figure 39: Multiple Change Since July



Source: Bloomberg Finance L.P.

Within this, we see CARR with a ~20% discount to the HVAC group on FY22 P/E with LII on the opposite end seeing a ~10% premium to the HVAC group. We see similar trends throughout all valuation metrics with CARR at a discount to both the EE/MI group and HVAC. JCI is also trading to some discount on P/E and EV/EBITDA, and a ~10% discount to HVAC on EV/EBITDA. On the other side, both Trane and Lennox generally enjoy premiums to both the group and HVAC, with LII seeing ~20% and ~30% premiums to HVAC group on P/E and EV/EBITDA respectively.

While Carrier's valuation discrepancy vs peers has narrowed since the initial spin-off driven by good execution on cost and better than expected markets, after the recent pullback and move up in JCI, we see too much of a discount versus closest peer TT, and see a roll off in investments that are heavily loaded in '21 as an offset to pressure from resi markets and a peak in transport refrigeration. Marking the 70% of their TT like exposure to the TT multiple suggests too much of a discount for Fire/Security (3x EBITDA). While this is attractive on a relative basis vs TT, it's not enough in our view to move from Neutral, but it looks like the best value today after the recent pullback. JCI is still at N, but our second favorite, as we believe that their recent investments, commercial market growth potential, and the shift in the markets towards more of an integrated offering is not reflected in the stubborn discount here. We remain UW LII as we believe the next 10 year cycle will end up materially more subdued than the last as residential markets are at maturity, and commercial unitary markets will remain competitive in a lower volume environment with less technology differentiation. Trane is probably the best franchise now, but this is discounted in the standing premium.

Table 31: EE/MI HVAC Summary

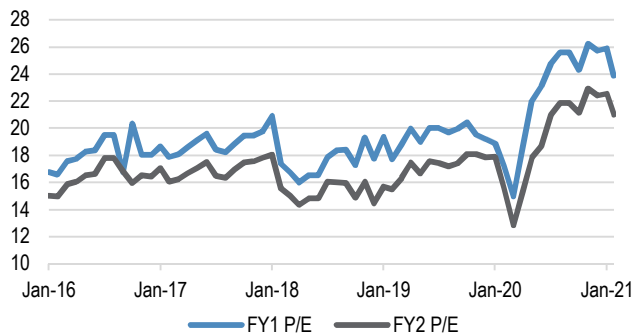
Stock	Rating	Price Target	High Level View
CARR	N	\$38	Management did a good job on cost out of the gate in a challenged environment, and some markets have been better than expected. While there is a ways to go on investing to position the company for sustainable growth longer term, and the company has some work to do when it comes to revitalization of the commercial franchise. In addition, we view the \$3.7 B residential business as less favorable now from a cyclical standpoint, while the cyclical upside at Transicold is now embedded in the consensus and likely flattens in '22. However, we think given relative end market exposure, the stock is probably the best value today, especially versus closest peer TT, using which suggests a modified SOTP value for Fire/Security at 3x EBITDA, too cheap.
TT	N	\$134	Best in class and differentiated HVAC company, with solid Climate franchises, top tier organic growth, effective execution on margins, and quality FCF. Like others, TT navigated the recession better this time driven by a mix of more diversified and less cyclical portfolio and better balance sheet optionality/lower leverage. That said, we think this franchise value is discounted and the earnings embedded at current levels are unrealistic in the context of non-residential HVAC markets and follow through on both residential growth from '20 and the growth expected at Thermo-king in '21, while IAQ and vaccine transport narratives seem overdone as tangible earnings drivers near term.
JCI	N	\$50	Past cycle investments are beginning to pay off with improving growth/orders, and JCI has some of the strongest integrated building offerings, especially with their recent announcement of the OpenBlue system which houses and emphasizes IAQ and efficiency controls under one roof. Near-term earnings may lag given non-res exposure, but moving into the next cycle their business model could emerge with better growth as the buildings market shifts more towards integrated systems. Quality of FCF is a key area that needs improvement, and we are optimistic this will be a focus under the new CFO, while recent cost programs show a tangible operating rigor that should close the gap versus peers that has been in place for some time.
LII	UW	\$255	While not losing share incrementally, Lennox has appeared to lose the market outgrowth position it had during the past 10 year cycle off the bottom, unable to fully re-capture share that was lost during the Tornado. Indeed, Goodman being out of the game in '20 would have been a prime opportunity for outperformance but others like Rheem and Carrier stepped up, highlighting the incrementally more competitive environment. From a macro perspective, Lennox is more weighted to resi vs. commercial, which was a positive during the pandemic, but medium term we see less end market tailwind than the past 5-10 years. The company enjoys a premium to other HVAC peers that we think reflects the last 10-year track record that is not necessarily indicative of future performance, and thus have a hard time getting behind the stock where it currently sits, and continue to see it as an over-valued asset.

Source: J.P. Morgan.

Valuation divergence: TT/LII the "rich" JCI/CARR "poor"

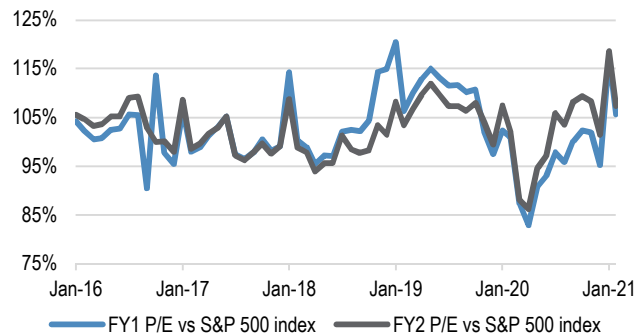
With better performance in residential through year end, and optimism around catalysts for commercial growth coming out of the COVID-19 experience, the multiples here have moved up, though there remains a material divergence among the players.

Figure 40: HVAC sector multiples have moved back up



Source: Bloomberg Finance L.P.

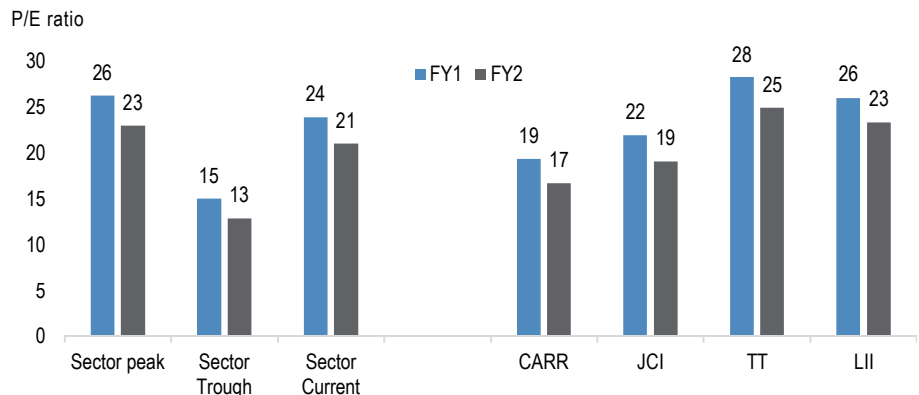
Figure 41: Relative multiples normalized from March bottom



Source: Bloomberg Finance L.P.

TT/LII are viewed as best in class, while JCI/CARR are viewed as somewhat lower quality catch-up/restructuring stories, for a lack of a better term. We don't disagree based on a high level review of the past cycle, but we see the potential for the leadership to change a bit. As for simplified P/E, after trading to ~15x at the lows in March, they are now at ~24x, with CARR and JCI trading at discounts to Trane and LII.

Figure 42: Valuation Divide- TT/LII Trade at Premiums to JCI/CARR



Source: Bloomberg

Looking more broadly across metrics, we see CARR at a 10-20% discount to the HVAC group across all metrics, with LII on the polar opposite end seeing 10-25% premiums. JCI sees a discount of around 10-15%, while TT is at around a 0-15% premium on average across metrics (most expensive on P/E, but relatively inexpensive on EV/FCFF). This level of valuation divergence between near peer names creates opportunities in our view, as cycle dynamics shift.

Table 32: HVAC Peer Valuation

	P/E		EV / EBITDA		EV / FCFF	
	FY1	FY2	FY1	FY2	FY1	FY2
CARR	19.0x	16.6x	14.3x	12.8x	22.6x	19.7x
JCI	21.4x	18.9x	13.6x	12.6x	23.1x	20.9x
TT	27.9x	24.3x	18.2x	16.5x	26.1x	22.8x
LII	25.4x	22.7x	18.4x	17.2x	32.8x	27.3x
Peer Avg	23.4x	20.7x	16.1x	14.8x	26.1x	22.7x

Source: Bloomberg, and J.P. Morgan estimates.

With the differences in capital structure and reporting style, we look at a harmonized view of EPS, EBITDA, and FCF across all HVAC names and see that in this adjusted matrix, LII sees a ~10-15% premium on average, while CARR sees the most significant discount (15% on average, weighed down most by P/E) and JCI is at a 5% discount on average, driven by 10% discounts on EV/EBITDA and EV/FCFF. On a weighted basis, with more emphasis on P/E and EV/EBITDA, we see ~15% discount to the group for CARR and 5% for JCI, while for TT we see a 5-10% premium and LII we see a 10-15% premium.

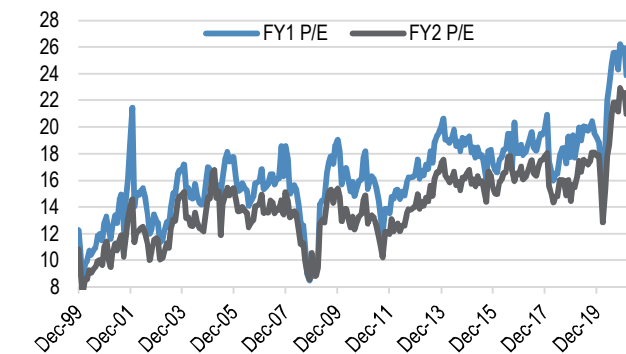
Table 33: HVAC Valuation Matrix Based on FY2

Premium/Discount	Adjusted GAAP P/E (including amortization, restructuring, normalized for pension)	EV/EBITDA (pension adjusted)	EV/FCF (unlevered, pension adjusted)	Weighted (2021)
CARR	79%	89%	87%	85%
JCI	101%	93%	91%	96%
TT	114%	107%	101%	109%
LII	106%	111%	121%	111%
Weights	40%	40%	20%	

Source: J.P. Morgan estimates, Company data.

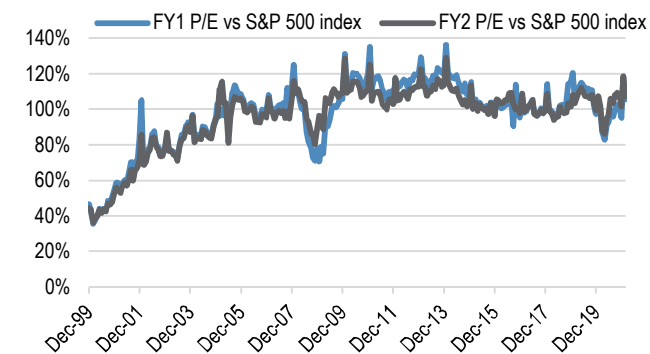
Historical valuation interesting but less relevant given changes in portfolio structure – Despite COVID-19 related impacts continuing to weigh on commercial HVAC markets, the group is currently about on par with its historical average relative to the market, at a 0-5% premium. Absolute multiples, however, are at all-time highs, breaking out with the market into uncharted territory. The charts below aren't perfect in that HVAC assets historically were part of industrial conglomerates. We include LII (the only pure-play for the entire data set) but also UTX historically, American Standard and York in the last cycle, which ultimately become Trane/IR and JCI this cycle, and more recently CARR, which broke off from UTX. In any event the data show a break higher to unprecedented multiples on P/E, albeit only a slight premium to the market, in line with historical levels.

Figure 43: HVAC sector multiples at unprecedented levels



Source: Bloomberg Finance L.P.

Figure 44: Relative multiple in line with historical 0-5% premium



Source: Bloomberg Finance L.P.

Other suppliers

There are several other companies that supply to the HVAC markets, though they are not the primary aspect of our investment thesis. Those companies include:

- *Honeywell (HON, Overweight rated)*—HON is a leading supplier of refrigerant to the HVAC industry. We view Honeywell as a transformed franchise versus past cycles as management has been successful in driving operational improvements while also investing in R&D and rationalizing the portfolio through divestitures and what we consider reasonably priced M&A. Fluorine remains a strong secular growth story with plenty of runway to help drive outperformance for HON over the next few years. Solstice is the key on increased environmental regulations driving adoption of low global warming refrigerants, with the non-flammable N41 positioned for growth on conversion of the stationary A/C market (an alternative to R410A). They are also relatively insulated from a competitive perspective, having invented most of the newer refrigerant products (Solstice patented until mid-20s), which allows them to gain share by replacing competitors' old products without cannibalizing their own. In Buildings, the company remains well positioned as a leading player in automation/controls, software, and services, with a product focus mostly in fire/security as opposed to HVAC, though an ability to integrate systems to help solve problems as per the \$2.1 B healthy buildings pipeline (\$665mm in sales in 2020), which includes solutions to address key customer concerns including air quality, social distancing, and access control.

HON's HBT business is a commercial buildings business, with a focus on high-level controls, building management, and connected software and services, and showing little correlation with non-res construction trends. It is one of the higher value non-res businesses in our group, well positioned for long term growth driven by connected building and building efficiency trends, in a high value market within the commercial buildings ecosystem, with some exposure to increasingly smart edge devices. At its 2019 HBT Investor Day, HON described a \$100B+ sector, driven by urbanization, climate change and regulations, where HBT can leverage its installed base and offer new products as disruptive offerings. The company talked about an ongoing trend toward connected buildings, as owners look to gain the next level of productivity on top of efficiency improvement from the major systems in isolation. In Connected Buildings which was \$0.3B in revenue, and expected to grow 10%+ annually over the next several years, they are trying to serve an increasingly consolidated market where more customers own multiple buildings, and they are trying to help with enterprise operational management, with Honeywell Forge the ERP for the operational technology. They see \$150 mm+ in recurring software sales over the long term and 10,000+ connected buildings. They also plan to stay equipment agnostic, focusing more on connected software and services as growth drivers, augmented by increasingly smart edge devices. The company targets MSD long term growth rate, driven by new product introductions, with initiatives around connected products and some new controller products across the various market segments/sizes. They also have a solid profit in high growth regions, which are targeted to grow 10%+.

More recently, Honeywell launched an integrated set of solutions in May 2020, Healthy Buildings, to help building owners comply with new hygiene and social distancing policies, provide real-time insights and analytics on indoor air quality, occupant flow, PPE analytics, thermal screening, social distancing and sanitation efficacy, as well as provide occupants with transparency into a building's health status. The Healthy Buildings solutions features a package focused on indoor air quality and a package on safety and security, and can be applied to commercial buildings, airports, hospitality, healthcare, and education sectors. HON also announced a partnership with the enterprise resource planning software company SAP to provide corporate real estate owners and building operators with integrated, cloud-based business and operational technology data, as buildings come back online and people come back to work. In 2Q20, HBT's Connected Buildings were up 26%. In 3Q20, Building Solutions service backlog was up DD, with a healthy building solutions sales pipeline of over \$600mm playing into the IAQ theme. In 4Q20, the Healthy Solutions pipeline which also includes PPE and some other solutions, was at \$2.1B and expected to grow meaningfully in 2021 driven by PPE/healthy buildings.

- *Emerson (EMR, Overweight rated)* – We think EMR, through its CRS segment, remains well positioned as the dominant supplier of compressors to the HVAC industry that is evolving successfully as technology steadily improves driven in part by the regulatory environment. What's under-appreciated, we think, is that the segment is more than US resi HVAC (25-30% of sales), an area currently being influenced by channel inventory fill, with other parts of the business like China that have been depressed for several years that should see an extended recovery and provide an offset to this once strength in US resi HVAC moderates. Here, the heating & comfort market is benefiting from decarbonization policies, driving an expected 10-15% CAGR in 2020-2023. Outside of China, other non-US resi HVAC drivers include Europe which is seeing strong demand from the EU heat pump decarbonization objectives that provide incentives for renewable heating, creating opportunity for heat pumps, which are on track to grow 25% in 2021 and expected to present a \$400mm opportunity by 2030 and \$700mm over the next 30 years. Additionally, cold chain, at 20% of the segment, is seeing strong investments in transport/supermarkets driven by a focus on vaccine distribution infrastructure and food safety. Overall, we are seeing a continued recovery in CRS, driven by an improving global economy and a focus on technology as regulations tighten, as well as margin expansion to new highs on the back of savings from recent restructuring actions.

Industry Snapshot and Summary of Key Players

Later in the report, we provide a full primer of each key HVAC product category; however, here we provide a brief synopsis of the key categories/players:

Residential: Residential HVAC (~\$42B market) is divided into two categories: ducted (central air/unitary) and ductless (room/window).

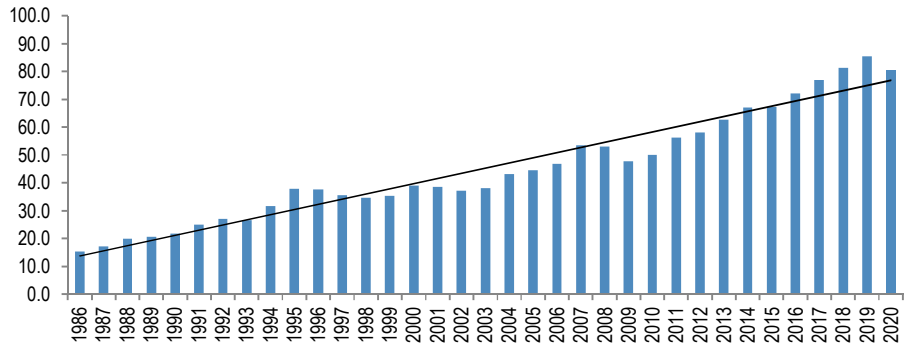
- **Unitary** represents ~30-35% of residential industry sales, with ~85% coming from replacement demand and ~15% new construction, almost entirely a US market. We estimate that the top four players represent >80% of sales. Carrier and Goodman are the largest players at ~25% share each, while Trane and Lennox have high teens share. Rheem, York, and Nortek round out the remainder of the market.
- **Ductless** is popular in international markets, like Asia, and smaller (but growing) in the US. Our report focuses less on the window units, given the major OEMs do not play in these increasingly commoditized spaces. Key players in window/room A/C systems include LG Electronics, Fedders, Haier, Whirlpool, Electrolux, Matsushita (Panasonic, National), Mitsubishi Electric (Melco), Fujitsu, and Gree. Mini-splits are another segment of the ductless market and a key part of the world market (especially in Asia), dominated by foreign manufacturers such as Daikin, Mitsubishi, LG, and Sanyo.

Commercial is broken into three categories: unitary, applied, and ductless. This report is focused on the unitary and applied markets.

- **Light Commercial (Unitary):** Unitary is an over \$6B market globally, and a ~\$5B market in North America in our estimates, and serves end markets such as institutional, retail, and government. The top manufacturers in the commercial unitary equipment space include Carrier, Trane, and Lennox, as well as York and AAON, which collectively make up ~80% of the industry, by our estimates. Frost and Sullivan estimates that there are probably 40-60 tier-two competitors, including AAON, with a big portion of this business going to higher cost, custom applications.
- **Large Commercial (Applied):** The large commercial equipment market is ~\$16B and is composed of two product components, applied equipment systems and chillers. Globally, large commercial remains a somewhat fragmented market, with the top four players at ~60-65%, less than residential and commercial unitary on a relative basis. Trane, Carrier, York and Daikin are the key players.
- **Variable Refrigerant Flow (VRF):** The global VRF market size reached ~1.86mm units in 2019 (up 5% y/y). Geographically, APAC was the largest VRF systems market, with China representing almost 60% of the total world market. As of 2019, the market for VRFs and mini-VRFs was still small, at ~68,800 units in the US, up 10% y/y. Asian players like Daikin/Mitsubishi are the leaders here, but US OEMs have begun to partner with Asian manufacturers to develop ductless products for distribution in North America.
- **Commercial Parts/Services:** Services is a large market that continues to grow in importance in the commercial marketplace as OEMs go to market selling a full “solution” suite of equipment, controls, and longer-term service contracts. Again, Trane, Carrier, and York are the key players here.

Figure 45: Global HVAC Equipment Market

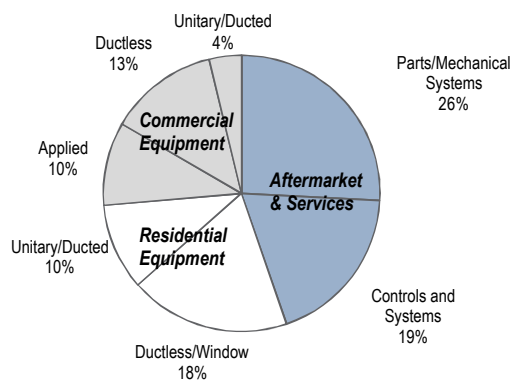
\$ in billions



Source: Carrier and J.P. Morgan estimates

Figure 46: Global HVAC Market (~\$147 billion)

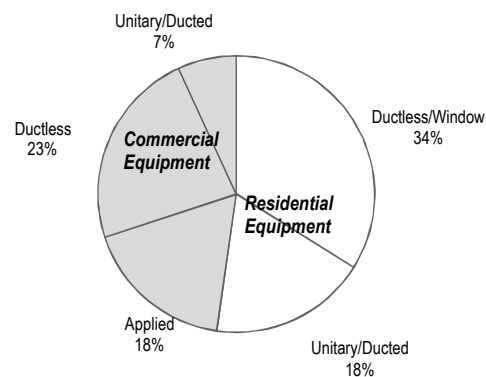
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Figure 47: Global HVAC Equipment Market (~\$81 billion)

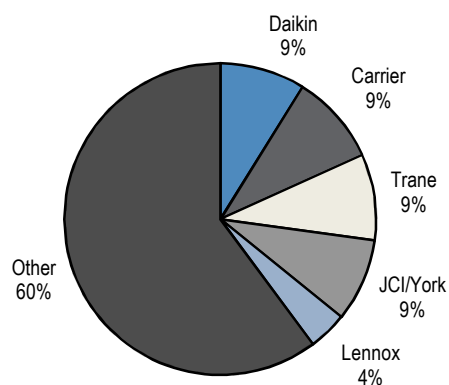
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Figure 48: Total HVAC Equipment Market

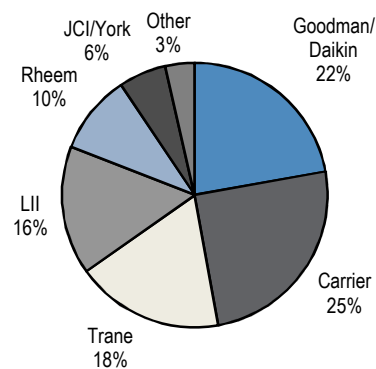
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Figure 49: North America HVAC Residential Unitary Equipment Market

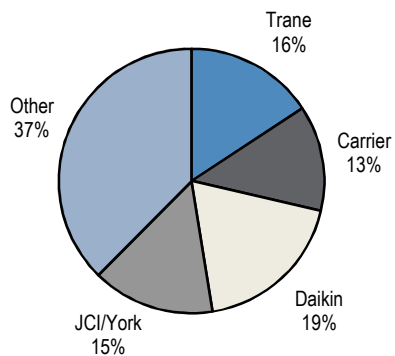
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Figure 50: Global HVAC Large Commercial Equipment Market

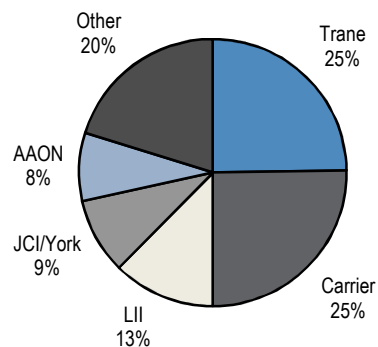
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Figure 51: North America HVAC Commercial Unitary Equipment Market

% of 2020 Industry Sales

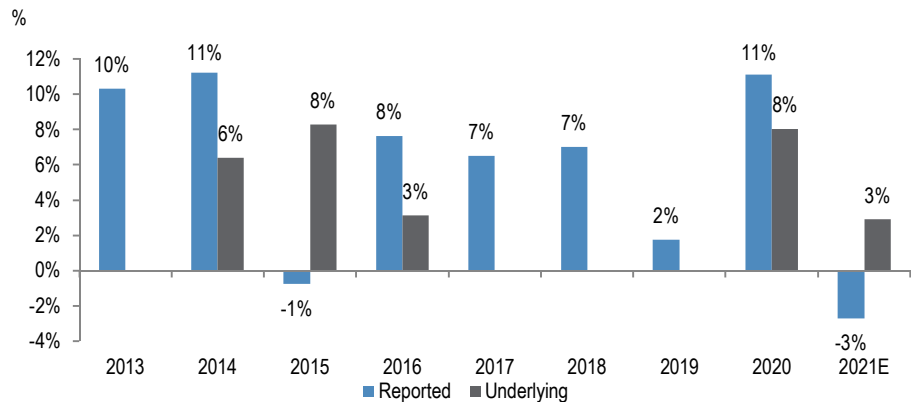


Source: J.P. Morgan estimates

Resi: Near-Term Market Estimates

Residential unitary HVAC equipment grew ~11% in 2020 following growth of +2% in 2019 and +7% in 2018, and we see slight declines in 2021. This section walks through the build of our near-term estimates.

Figure 52: Residential HVAC Shipment Growth

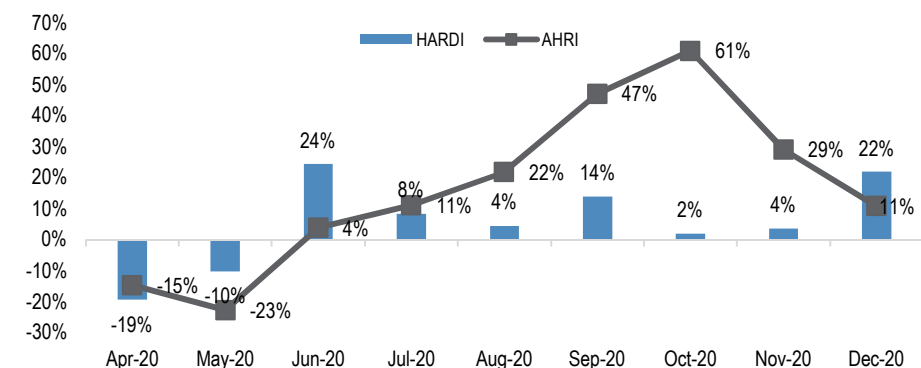


Source: AHRI and J.P. Morgan estimates. Note: We estimated that ~285K units of 13 SEER pre-buy was pulled into 2014, which increased 2014 growth by ~4% on the lower comp, so the "underlying" growth trend for 2014-2016 was smoother than the headline numbers, as depicted in the chart. For 2020, we estimated a COVID-19 inventory planning impact of ~250K units, which we assume reverses in 2021, showing an underlying growth trend in the 8% range for 2020 and 3% for 2021.

AC/Heat Pump Unit Forecast

To start and level set the discussion, we show how 2020 finished out, what we call a "cycle within a season." 3Q was up on pent-up demand from April and May, but pent-up demand faded quickly and 2H strength is now a tough comp for 2021. Stepping back to industry data, sales growth flipped as per AHRI showing 28% growth in 2H after a 4% decline in 1H. HARDI, however, was more stable, and saw 9% growth in 2H after a 2% increase in 1H. This shows the bifurcation in sell in and sell through, and the initial cuts in channel inventory which the OEMs described as around 25%, followed by a channel re-fill, similar to what we saw at WSO.

Figure 53: AHRI vs. HARDI: AHRI "sell in" growth accelerated in the quarter while HARDI "sell-through" normalized



Source: J.P. Morgan estimates, HARDI, and AHRI

It is clear that the weak April/May in 2020, and perhaps even the end of March, created a pent-up demand situation, which is the key driver of the material order

increases seen in June and a strong July that carried into year-end, and something which we make an effort to parse through and put some numbers around below.

Keep in mind that in the beginning of 2020 we were late in the residential cycle, and even before COVID-19, January and February were down ~4%, with comps at most players negative for 1Q (though HARDI was +2%, AHRI residential ended up +5% in the quarter). Assuming the trend line would have been up LSD this year, in line with pre-COVID-19 guidance, we saw the potential for remaining pent-up demand of about ~370 thousand residential units from the April and May lows. With June up 5%, this left ~350 thousand of pent-up demand. This moved to 272k in July and 119k in Aug, with Sept growth of 23% needed to fully catch up, by our math. The 50% increase for September was 155k units above what was needed, and is not indicative of end market demand, suggesting the channel was now fully, even over-stocked, curious given the next selling season was a full 6 months away. This strength continued into October and through 4Q. The point is that for this mini-cycle, a good 3Q/4Q has eaten into all of what was pushed forward, and the risk is that results could recouple to where consumer trends are, which remain negative when using U/E and consumer confidence, as well as retail spending trends that have flattened out. There could also be a degree of double ordering or channel fill, ultimately pulling forward some orders and sales into 2020, setting up for a tougher comparison for 2021, perhaps why most OEMs are grounded in calling for LSD growth with almost all of them calling for strong growth in 1H, offset by weak growth in 2H, which is what we are forecasting.

Table 34: Scenario Analysis (units in 1,000s) Shows 3Q Eats Up All Pent-Up Demand

	2019	2020	AHRI Y/Y	HARDI Y/Y	Pent Up Demand Assuming 3% Trend
April	720	618	-14%	-19%	123.9
May	977	760	-22%	-10%	246.7
June	1,038	1,088	5%	24%	(18.9)
Pent Up Demand Still Left	2,735	2,465	-10%	0%	351.6
July	876	982	12%	8%	(79.4)
Pent Up Demand Still Left					272.2
August	749	924	23%	5%	(152.9)
Pent Up Demand Still Left					119.3
September	587	879	50%	14%	(274.5)
Pent Up Demand Still Left					(155.2)
3Q Total	2,212	2,785	26%	9%	
October	492	808	64%	2%	(301.4)
November	439	575	31%	4%	(122.7)
December	487	544	12%	22%	(42.6)
Pent Up Demand Still Left					(621.9)
4Q Total	1,418	1,927	36%	9%	
% LTM units					~8%

Source: J.P. Morgan estimates, Company data, AHRI.

The Forecast

Moving onto the forecast, we start with a view on unit sales of condensing AC units and heat pumps, the primary metric tracked in AHRI data. For purposes of definition, we focus on AHRI shipments below 65 BTUH. We exclude units above 65 BTUH, which are typically for light commercial applications, and focus just on the remaining AHRI shipments, which are assumed to be all for residential use.

We begin by breaking unit demand into (1) new housing and (2) the replacement/add-on market. In forecasting replacements, our approach is to start with the number of unit breaks, or “replacement opportunities,” each year. This is with a view that a homeowner with a broken central A/C system can do one of several things:

- *Replace with a similar outdoor condensing unit*—This is likely to be an R-410A unitary condenser, although a consumer could also choose a mini-split. Increasingly, with advances in technology, this is either an air conditioning unit and a furnace or a heat pump.
- *Repair the broken part*—This is typically the compressor or, occasionally, other parts like motors. The OEM would not see this revenue, given no new condensing unit sale, but the contractor would likely buy the replacement part from a distributor and bill for the service. This would keep the existing system in place.
- *Substitute with window units*—Alternatively, the homeowner could forgo central AC altogether and opt for lower-cost window units. Window units are generally purchased through a big-box retailer and frequently self-installed, meaning distributors and contractors would not see the revenue.

For purposes of our model, we ignore some of the longer-term trends that may affect replacement such as underlying penetration rates, shifts in the age of the installed base, or changes in the average useful life of the equipment. While these are relevant debates for the long term (discussed later), we believe there is too much noise in year-to-year data for this to be meaningful in the very short term.

New housing pickup should help overall HVAC growth

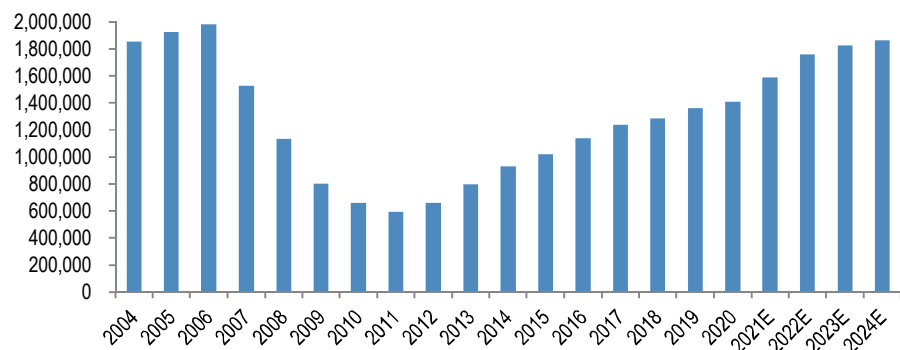
Data on the US housing market are widely available and closely followed. Housing starts finished 2020 at 1.38 million (+7% y/y) following a 3% increase in 2019, and we expect 1.6 million in 2021 (+18% y/y), in line with estimates from the JPM economics team. Despite fears of a severe downturn when COVID-19 surfaced in the Spring, the year ended up growing, which compares favorably to the severe decline in the last recession, with housing starts dropping ~38% in 2009.

- Sales of HVAC equipment are more closely linked to housing completions, which we assume trail starts and have them going to 1.45 million 2021 (+13% y/y, from +2% completion growth in 2020) and 1.62 million in 2022 (+12% y/y).
- We assume approximately one unit per completed home, based on an assumed ~94% penetration on new single-family construction and 1.1 units per single-family home.

This results in new housing units of ~1.59mm in 2021 and ~1.76mm in 2022, up from ~1.41mm in 2020 and a peak of close to 2mm in 2006.

Figure 54: AC/Heat Pump Units for New Residential Construction

Units

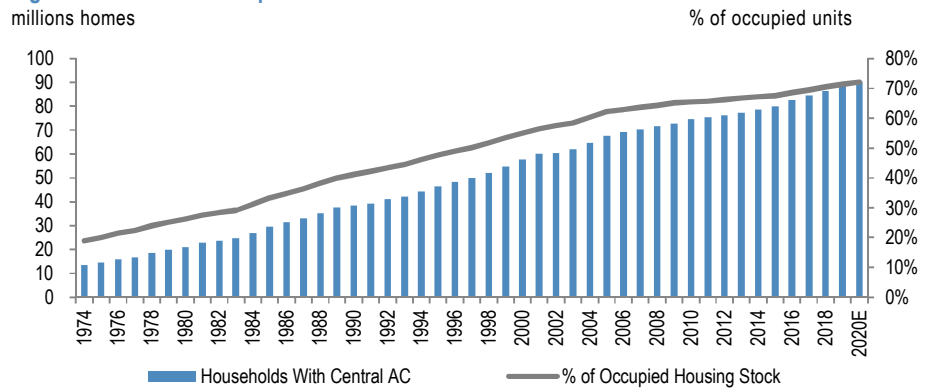


Source: J.P. Morgan estimates

Replacement demand forecasts are more nuanced

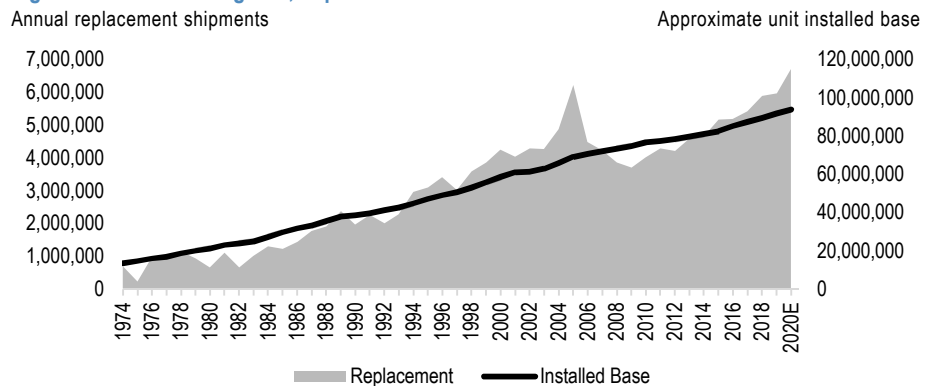
Weather and “replacement opportunities”—It is difficult to estimate, with precision, the exact number of broken units in any given year. At a conceptual level, we would expect the growth rate of broken units to roughly approximate the growth in the installed base over time, which we estimate at ~5% between 1980 and 2000 and ~2.5% between 2000 and 2019 (see our medium-term market model for more detail here). As we discuss later, with estimates of unit average life ranging from 10 to 20 years and the rate of unit obsolescence/breakage tough to quantify, it can be difficult to precisely estimate the age of the installed base at any point in time, and we are now using Carrier’s historical data as a check vs. our model.

Figure 55: Growth in Occupied Homes with Central AC



Source: US Census, HUD, J.P. Morgan.

Figure 56: Over the Long Run, Replacement Demand Has Grown with the Installed Base

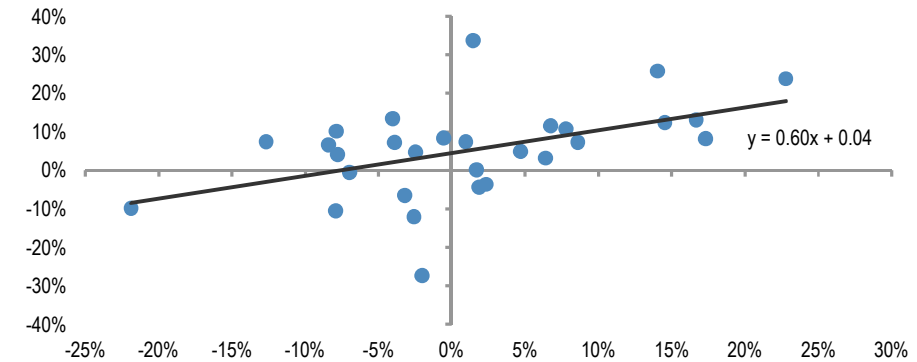


Source: AHRI, US Census, J.P. Morgan estimates. Note: Replacement above excludes new construction and estimated add-on adoption.

What about the weather? While it would seem to make sense that the number of broken units in any given year is also highly dependent on weather as systems are more likely to break when being run harder, recently, there has been little proof of a correlation. Our preferred proxy for weather is the NOAA's cooling degree days, meant to estimate the population-weighted cooling requirements nationally. There is somewhat of a relationship between weather and replacement shipments (many other factors influence demand), as history suggests that each 1% increase in cooling degree days would, on average, be accompanied by a ~0.6% increase in replacements.

Figure 57: Annual Cooling Degree Days Y/Y vs. Replacement (Non-New Housing) Shipments Y/Y

Left axis: Y/Y replacement shipments; Bottom Axis: Y/Y cooling degree days

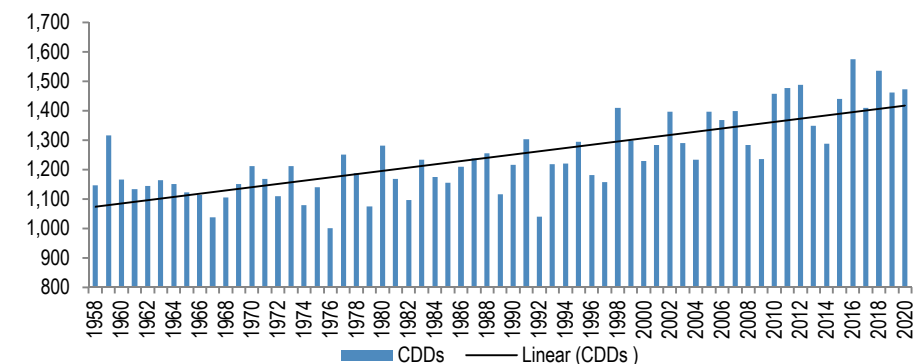


Source: NOAA, AHRI data, J.P. Morgan estimates.

According to NOAA cooling degree data, 2016 was the hottest year on record, though most of the impact came in the latter part of the summer, which likely limited potential upside as it is generally better for HVAC replacement to get heat early in the summer (Apr-Jun was down HSD while Jul-Oct was up high teens y/y). With continued global warming trends, global surface temperatures in 2018 were the second warmest since 1880, behind 2016, also implying that the past five years are the warmest years collectively on record. Looking back beyond the past several years, 2010-12 were among the hottest summers on record in terms of cooling degree days, with 2013 still above average but less extreme (down 10% y/y) and 2014 below average. 2015 rebounded with a hot summer and a >10% increase in cooling degree days, though still a bit below 2010-12 levels, followed by the very hot 2016, some moderation in 2017 and a rebound to high levels in 2018. In 2019, CDDs remained above normal, albeit down 5% y/y, an aspect of the macro HVAC replacement cycle that helped to dampen 2019 results. Turning to 2020, CDDs were up about 1% y/y, and remained above normal levels.

Figure 58: 2016, 2018 the two warmest years on record, 2019/2020 remaining above normal

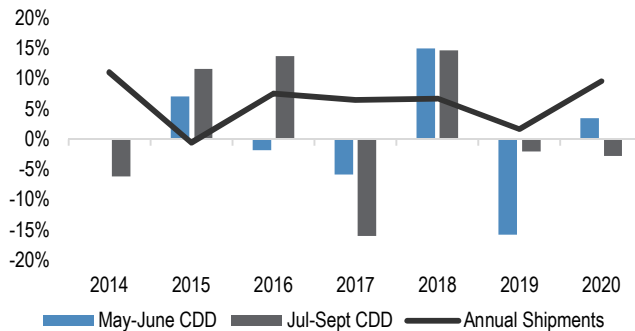
Cooling Degree Days, National Population Weighted



Source: NOAA.

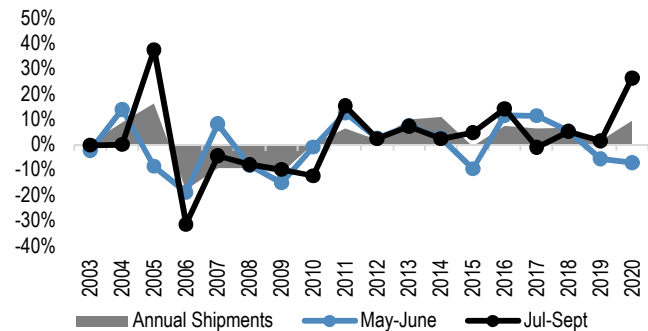
Despite volatility in cooling degree days, the growth rate of annual shipments has averaged MSD % from 2016-20. CDDs were down ~10% in 2017, then up ~9% in 2018, down ~5% in 2019, and up close to 1% in 2020.

Figure 59: CDD by Month vs. Annual Shipments



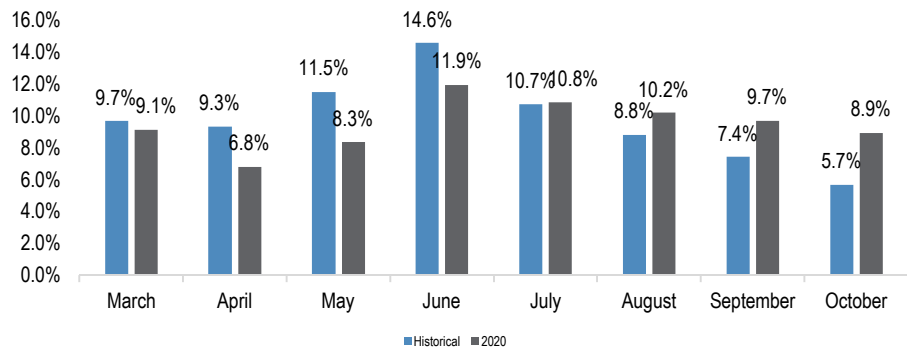
Source: NOAA and AHRI.

Figure 60: Early/Late Season Shipments vs. Annual Shipments



Source: NOAA and AHRI

Figure 61: Historical % Shipments by Month vs. 2020



Source: AHRI

Extending the analysis back further to last cycle doesn't give us much additional insight as there was noise around the 10-13 SEER transition as well as the housing boom and recession, and unaffected years generally had more consistent weather in early vs. late summer. However, 2004 presents another potentially instructive case where there was good heat early (CDD +16% in May-Jun) and less heat late (CDD -13% in Jul-Sept), and annual shipments grew by +9% (though the housing boom certainly contributed). In 2019 we see the drop in CDD (-16% for May-June) correlate to a drop in shipments over the same period (-6%), as well as the fall-off in CDD for July-Aug slowing to -2% from +15% in 2018 correlating to the drop from +5% to +2% for shipments. This tie of CDD to shipments likely provided some support to 2020 shipments as a warm June/July/August helped offset some COVID-19 related demand weakness early on in the selling season.

Table 35: CDD vs AHRI Core A/C Shipments

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
May-Jun CDD	-11%	16%	-4%	4%	3%	3%	-9%	24%	-8%	3%	-8%	0%	7%	-2%	-6%	15%	-16%	4%
July-Aug CDD	-7%	-13%	28%	-8%	0%	-9%	-3%	22%	1%	-2%	-9%	-6%	12%	14%	-16%	15%	-2%	-3%
May-June Shipments	-2%	14%	-9%	-19%	8%	-8%	-15%	-1%	13%	3%	7%	3%	-9%	12%	12%	5%	-6%	-7%
Jul-Sept Shipments	0%	0%	38%	-32%	-4%	-8%	-10%	-12%	15%	2%	7%	2%	5%	14%	-1%	5%	2%	26%
Annual Shipments	1%	9%	16%	-18%	-9%	-9%	-11%	0%	6%	2%	10%	11%	-1%	8%	6%	7%	2%	10%

Source: AHRI and NOAA

Table 36: 2019/2020 HARDI and AHRI Data by Month

	HARDI (monthly sales change)	AHRI (y/y monthly change in shipments)	Average Change Sales/Shipments
2019			
Jan	4.4%	7.5%	5.9%
Feb	12.2%	2.4%	7.3%
Mar	8.1%	-1.8%	3.1%
April	22.3%	1.4%	11.8%
May	-1.9%	3.5%	0.8%
June	-2.9%	-4.3%	-3.6%
July	14.9%	2.0%	8.5%
Aug	2.7%	5.1%	3.9%
Sep	11.9%	3.0%	7.5%
Oct	3.0%	1.8%	2.4%
Nov	0.2%	2.1%	1.2%
Dec	6.6%	3.4%	5.0%
2020			
Jan	0.8%	4.1%	2.4%
Feb	-0.4%	5.8%	2.7%
Mar	3.4%	4.7%	4.1%
April	-19.2%	-14.7%	-16.9%
May	-10.2%	-22.7%	-16.4%
June	24.3%	3.8%	14.1%
July	8.4%	11.1%	9.8%
Aug	4.5%	21.8%	13.2%
Sep	13.9%	47.1%	30.5%
Oct	2.0%	61.0%	31.5%
Nov	3.6%	29.1%	16.4%
Dec	21.9%	10.9%	16.4%

Source: HARDI/AHRI

Table 37: Cooling Degree Days, 2009-2020

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2009-2020 Avg	2014-2020 Avg
CDD														
May	109	131	120	146	110	119	126	106	107	141	122	108	120	118
June	222	279	256	242	247	238	256	269	246	265	220	246	249	249
July	294	385	411	408	351	308	342	387	364	376	378	396	367	364
August	307	356	347	330	297	292	312	374	284	353	331	345	327	327
September	166	196	184	183	193	189	227	241	194	236	237	179	202	215

Source: NOAA

Table 38: Cooling Degree Days, May-June, June-Aug 2014-2020

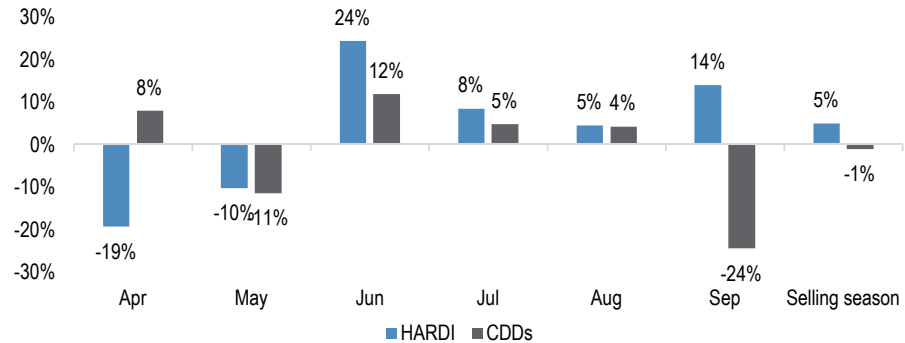
	2014	2015	2016	2017	2018	2019	2020	2009-2020 Avg	2014-2020 Avg
May-June	357	382	375	353	406	342	354	369	367
June-Aug	838	910	1030	894	994	929	987	943	940

Source: NOAA

During the 2020 selling season, the correlation was tight from May-August, with April and September moving in opposite directions due to the added consideration of COVID-19 impacting HARDI shipments. HARDI sell-through data was up by a solid 5% on average through the selling season, which includes the historically bad print in April of -19%, while CDDs ended down 1% y/y as a weak September offset a warmer than normal April.

Figure 62: HARDI vs CDDs

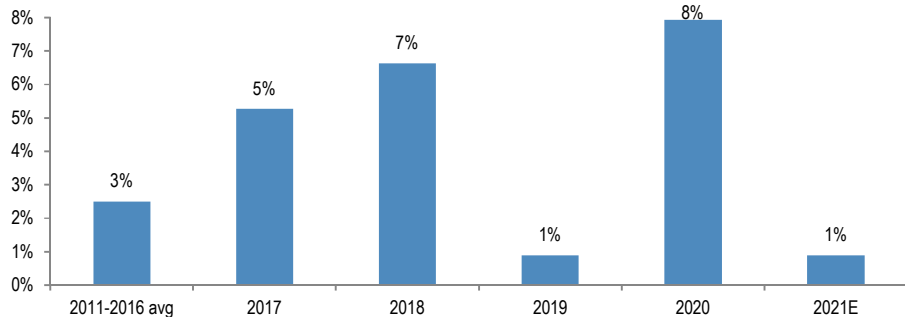
Y/Y growth



Source: NOAA, HARDI

Replacement “opportunity” forecasts. Our estimates assume unit breaks, or “replacement opportunities,” rose close to 8% y/y in 2020, up from 1% growth in 2019 as “stay at home” dynamics related to COVID-19 combined with warm weather to drive increased utilization of the equipment. We assume some normalization in 2021 and forecast 1% growth in unit breaks, with the 2-year average for 2020/2021 of 4% growth, in line with recent years of above average replacement opportunities.

Figure 63: Growth in Replacement Opportunities (Unit Breaks)

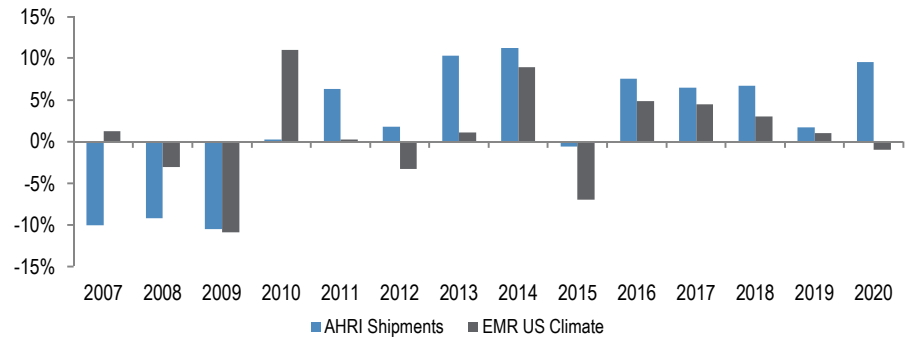


Source: J.P. Morgan estimates.

Unit repairs—We are not aware of any reliable data for repair-related sales of products such as compressors or motors. Our estimates, based on conversations with those in the industry, suggest that sales of replacement compressors peaked at slightly over 1 million units per year coming out of the recession. Directionally, we follow these trends by comparing the growth rate of Emerson’s US Climate sales to AHRI shipments. This is not a perfect proxy for residential compressor sales, as EMR sales also include commercial/refrigeration products, but we think it is a good starting point for analysis. We see that EMR Climate outperformed AHRI shipments in 2007-10 as consumers elected for more repairs but has lagged over the last six years. To a lesser extent, we found this is also apparent in WSO’s sales of products versus equipment (though WSO’s “products” category also includes a significant piece of revenue for new housing). With replacement demand picking up over the past several years, we estimate that repair activity stepped down ~10% per year in 2013-2016, and we assume flattish trends going forward as the “pent-up replacement demand” dynamic is now later innings.

Figure 64: EMR US Climate Sales vs. AHRI Unit Shipments

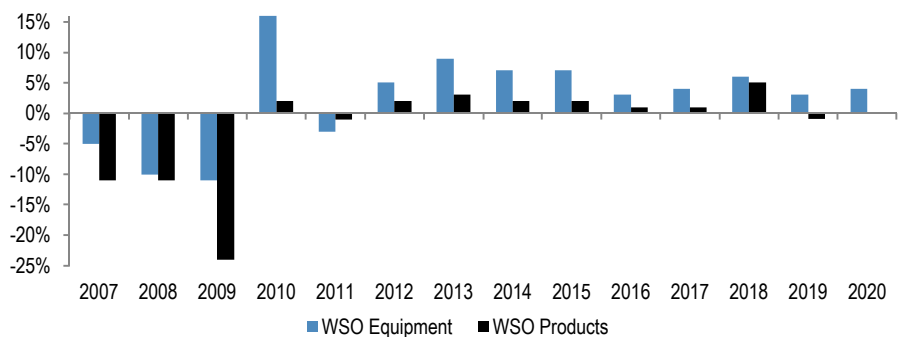
% change y/y



Source: AHRI; Company reports.

Figure 65: WSO Products (Including Replacement Parts) Gaining Ground with Equipment

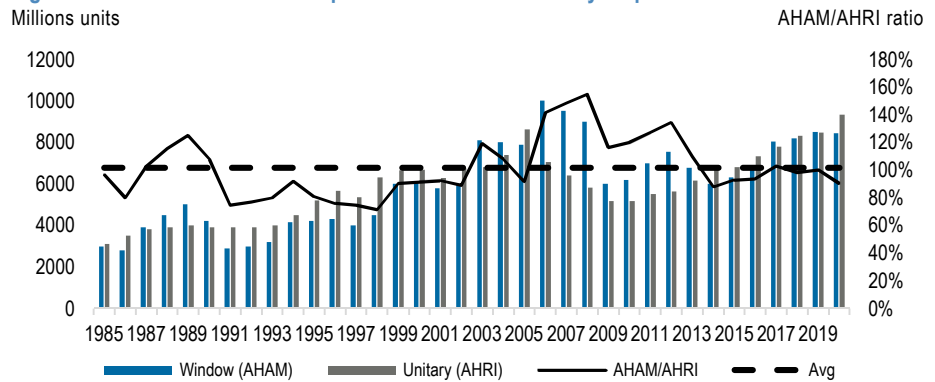
% change y/y



Source: Company reports.

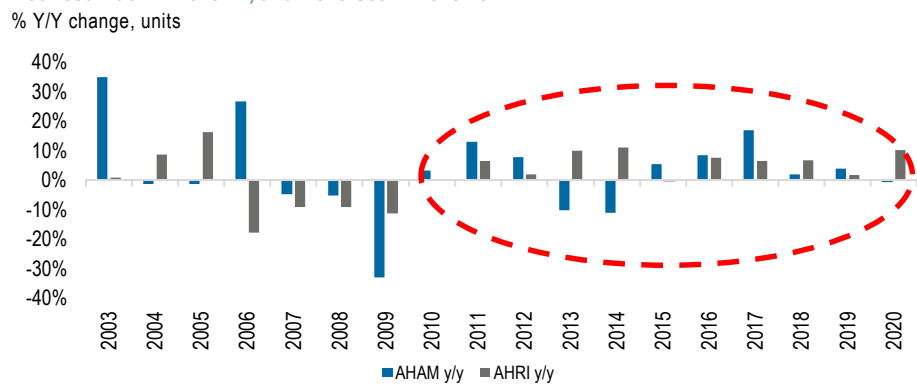
Window unit substitution—During times where replacement demand is depressed, anecdotal feedback from the channel suggests that there is some degree of substitution where broken central air systems are replaced by window/room units. Indeed, looking at AHAM shipments of US room air conditioners, we see that the proportion of room air conditioners to unitary shipments remained elevated into 2012 before normalizing from 2013 onwards, a move that coincided with big upticks in unitary replacement demand. The US Census's American Housing 2019 survey (latest available year) showed a slight uptick in 2011 in the number of homes reporting use of room air conditioners after years of decline, then resumed its downward trend from 2012-2019. We think mosaic theory suggests some substitution in 2010-12 that normalized in 2013, with the proportion of room air to unitary air continuing its steady march downwards. Quantifying the exact degree of substitution is difficult; however, our best estimate is that window/room air substitution peaked at ~2.5% of annual unit breaks, a significant portion of which reversed in 2013 with some modest additional improvement in 2014. In recent years, window units outgrew unitary shipments in 2015-2017, though that reversed in 2018 and 2019, and further disconnected in 2020. The proportion of room A/Cs to unitary shipments is now at the low end of the historical range.

Figure 66: AHAM Window Unit Shipments Versus AHRI Unitary Shipments



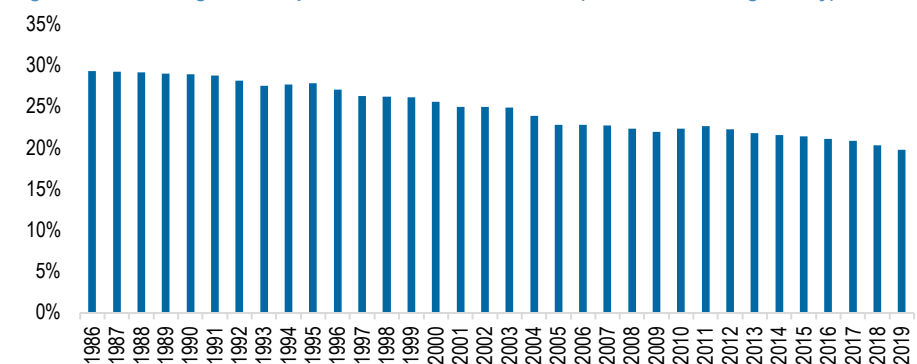
Source: AHAM, AHRI, J.P. Morgan estimates. Note: AHAM window A/C units were down ~2% YTD through September 2020.

Figure 67: After Outgrowing Unitary Shipments in 2010-12, Window Units Dipped in 2013-14, Bounced Back in 2015-17, and Reversed in 2018-19



Source: AHAM, AHRI, J.P. Morgan estimates. Note: AHAM window A/C units were down ~2% YTD through September 2020.

Figure 68: Percentage of Occupied Homes with Window A/C (American Housing Survey)



Source: US Census.

End Result: forecasted unit decline 2021

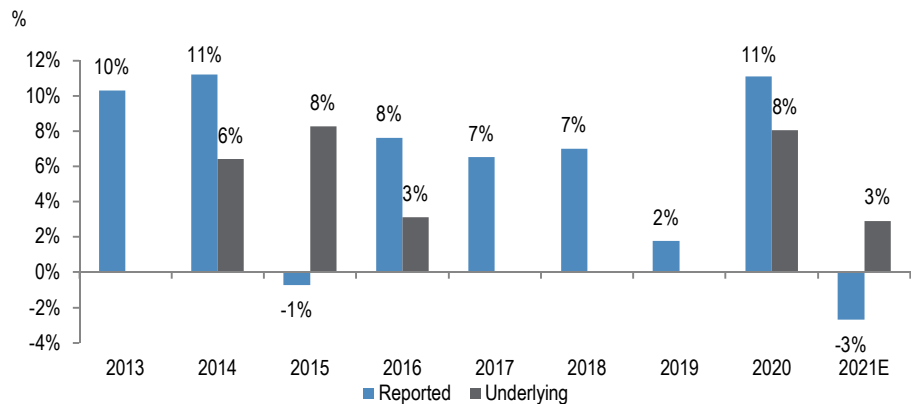
The table below summarizes our near-term assumptions. We see a 3% decline in 2021 given tough comps to what we view as a pre-buy. Our analysis incorporates 13% growth in 2021 in new housing units. Total units for add-on/replacement demand likely increased 10%+ in 2020, amplified by what we estimate was ~4% contribution to growth from COVID-19 inventory planning, which becomes a headwind in 2021. After incorporating this, we see a MSD % decline for add-on/replacement in 2021, entirely driven by the tough comps to the inventory pre-buy.

Table 39: JPM Residential Unit Model Forecast

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E
Housing completions	641,417	763,167	882,667	965,250	1,059,250	1,151,000	1,184,900	1,255,100	1,286,400	1,447,796
New housing units	658,416	794,457	931,732	1,017,800	1,135,732	1,236,737	1,287,370	1,360,424	1,406,557	1,588,017
"Replacement opportunities" (unit breaks) Y/Y	6,197,421 2%	6,360,356 3%	6,456,878 2%	6,696,908 4%	6,792,539 1%	7,150,063 5%	7,624,481 7%	7,692,192 1%	8,301,759 8%	8,375,862 1%
Add-on/replacement condensing units Y/Y	4,709,421 1%	5,127,396 9%	5,369,714 5%	5,805,433 8%	5,901,064 2%	6,258,588 6%	6,733,007 8%	6,800,718 1%	7,410,285 9%	7,484,388 1%
Unit repairs Y/Y	1,313,000 1%	1,207,960 -8%	1,087,164 -10%	891,474 -18%	891,474 0%	891,474 0%	891,474 0%	891,474 0%	891,474 0%	891,474 0%
Pre-buy / inventory planning impact			285,000	(285,000)					250,000	(250,000)
Total condensing units Y/Y	5,367,837 2%	5,921,853 10%	6,586,446 11%	6,538,233 -1%	7,036,796 8%	7,495,325 7%	8,020,377 7%	8,161,142 2%	9,066,842 11%	8,822,405 -3%
Implied compressors (new & replace) Y/Y	6,418,237 2%	6,888,221 7%	7,456,177 8%	7,251,413 -3%	7,749,976 7%	8,208,505 6%	8,733,557 6%	8,874,322 2%	9,780,022 10%	9,535,584 -2%

Source: JP Morgan estimates. Note: AC/heat pump unit shipments, except where noted.

Figure 69: Total Resi HVAC Shipment Growth



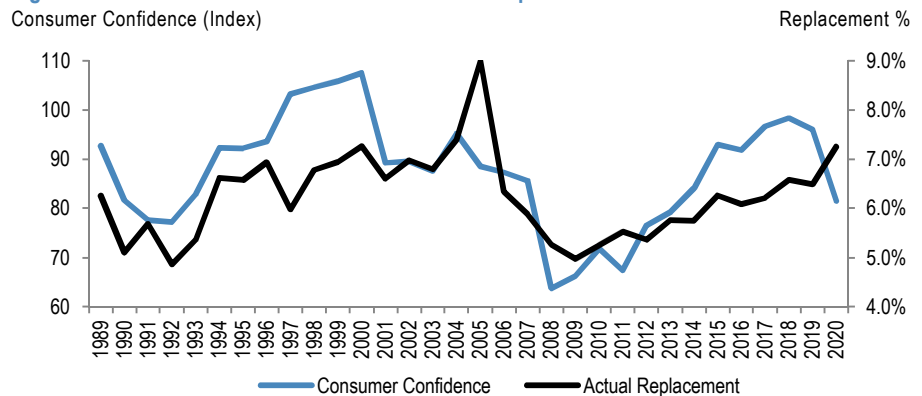
Source: AHRI and J.P. Morgan estimates

Mixed Fundamental Demand Backdrop: High Unemployment, Consumer Confidence Down, But Stay at Home and Heat Offset...For Now

General macro trends negative on back of COVID-19 induced recession

To describe the macro environment as complex would be an understatement. The key macro drivers to replacement highlighted above are consumer confidence, unemployment, and housing. As shown below, HVAC replacement rates are partly driven by consumer confidence, as consumers with a greater sense of security and confidence will be more likely to replace aging/broken HVAC systems during times of relative prosperity compared to tightening economic conditions. Per the chart below, this dynamic was particularly evident during 2008-2009 recession when replacement rates were at historic lows; as well as the steady upward trend in rates that followed as consumers regained confidence.

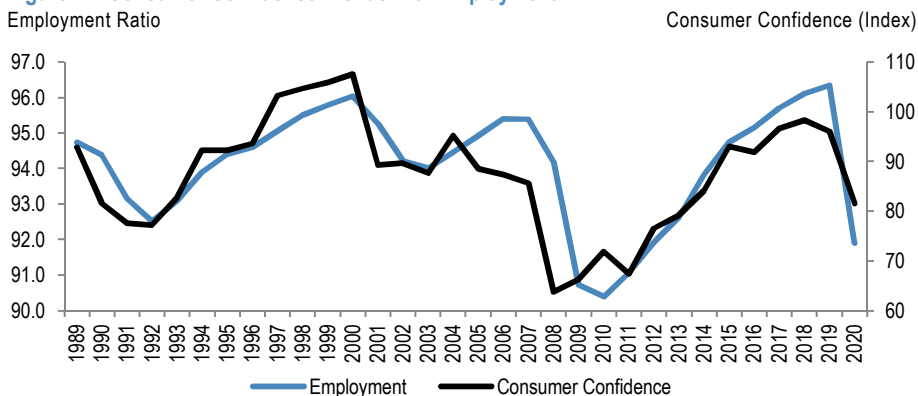
Figure 70: Consumer Confidence a Factor in HVAC Replacement Rates



Source: Thomson Reuters U Michigan, AHRI, and J.P. Morgan estimates

We show below the positive correlation between employment and consumer confidence. As illustrated below, consumer sentiment has historically trended in line with lower unemployment as consumer confidence rises with job stability. Coming out of 2019 unemployment in the US remained at historically low levels, which translated to the highest consumer confidence since the 1990's and more discretionary spending. With the onset of COVID-19, we have seen unemployment increase as well as a decline in consumer confidence, and while we have seen better data come through recently compared to the spring (consumer confidence at ~80 vs low-70s at the bottom, unemployment at ~6.3% currently vs ~15% at the low), JPM economists still expect unemployment to remain at elevated levels into next year (2021 seen at 5.2% vs. 3.7% in 2019), which could dampen the bounce back in consumer spending.

Figure 71: Consumer Confidence Trends with Employment



The charts below also illustrate the general correlation between the price of retail gas vs. consumer confidence and with retail gas prices averaging well below the \$3 level nationally, consumer confidence and spending remained positive since 2015 through 2019, though the data in 2020 showed a bucking of this trend given the unique situation of COVID-19 with declining consumer confidence as well as a decline in gas prices.

Figure 72: Retail Gas Prices Tend to Follow Crude Oil Prices...

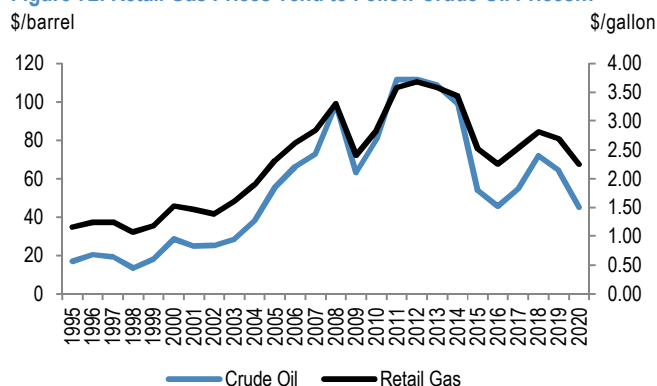
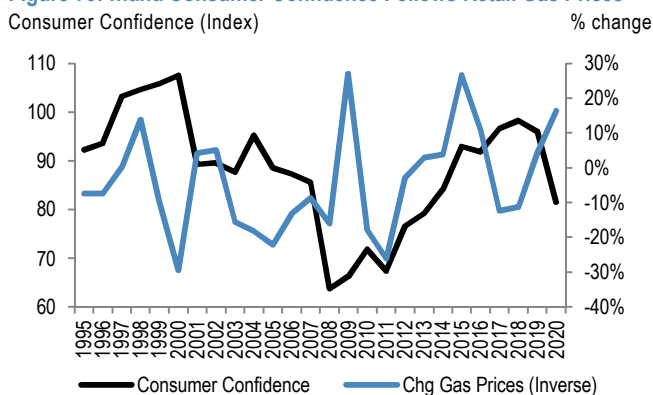
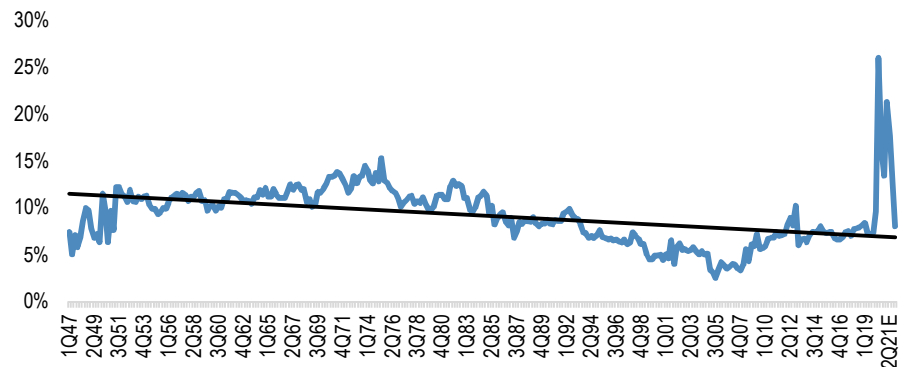


Figure 73: ...and Consumer Confidence Follows Retail Gas Prices



A wrinkle here is the personal savings rates (personal saving as a percentage of disposable income), which, after dipping to all-time lows during the prior cycle peak, have generally remained at the historic trend line since 2000, revealing that consumers were generally in a stable economic position exiting 2019. The savings rate moved higher during the pandemic, not uncommon after a recession, driven by a shift towards caution, and while consumer spending should move higher over time once a vaccine starts to be distributed, the pandemic could generate a longer-lasting shift toward saving and away from spending. According to JPM economists, the savings rate should move down over time as consumer spending picks up, but it could stay elevated vs. pre-virus norms, with expectations for it to average 8% in 4Q21, roughly 0.7%-pts above the 4Q19 level.

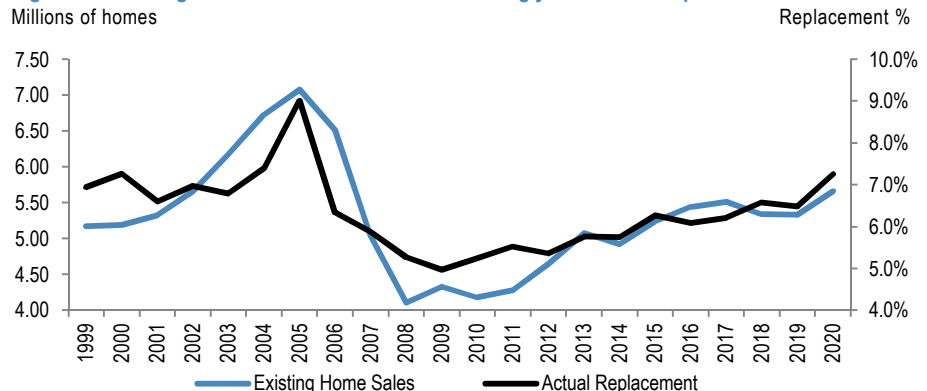
Figure 74: Personal Savings as % of Disposable Income 1947-2021E



Source: U.S. Bureau of Economic Analysis

As illustrated below, there has also been a strong correlation between HVAC replacement rates and existing home sales, with both trending steadily upwards since 2010. In 2019 we saw some slight divergence with flattening home sales while replacement continued to rise, however in general we see home sales as a solid read-through for replacement.

Figure 75: Existing Home Sales Have Correlated Strongly with HVAC Replacement Rates



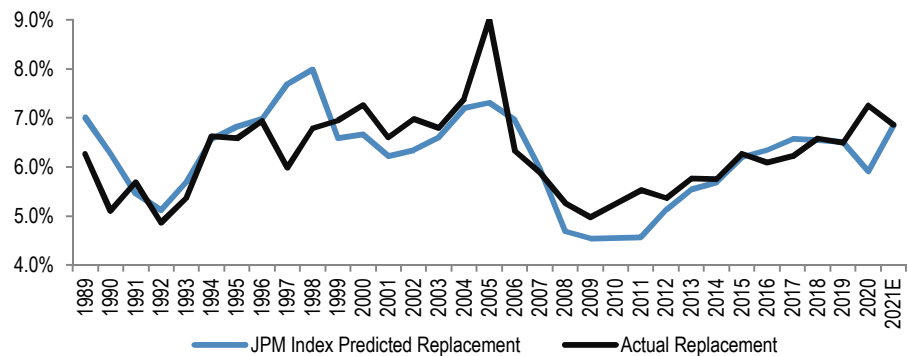
Source: NAR, AHRI, and J.P. Morgan estimates

In summary, utilizing these data points, we are able to create an index of economic indicators that correlates with HVAC replacement rates going forward based on forecasts for consumer confidence, employment, and existing home sales. We apply a 65% weighting to existing home sales, 25% to consumer confidence, and 10% to the unemployment rate, then plug into our formula summarized below to get an implied replacement rate. Back-testing this index over the last ~20 years gives us a correlation of ~85% with our actual calculated replacement rates. Going forward, inputting assumptions for these indicators based on widely available forecasts yields an implied replacement rate of ~5.9% for 2020, below the ~6.5% on average from 2017-2019 and the historical replacement levels in the 5-7% range.

$$\text{Implied Replacement Rate} = 65\% * \text{Existing Home Sales} + 25\% * (\text{Consumer Confidence} / 10) + 10\% * (10 - \text{Unemployment Rate})$$

We note that our economics database only includes existing home sales data from 1999 forward, so in the chart below we adjust our consumer confidence and unemployment weights to 50/50 for the years prior. The actual replacement rate that we estimate for 2020 of 7.3% is well above the JPM Index predicted replacement noted above (5.9%), a "macro disconnect" driven by a combination of unprecedented stimulus, work from home, and a likely wider gap between unemployed persons among homeowners vs. renters. We quantify this lift vs. the macro as adding around 15% growth to replacement units in 2020, while a step down to JPM Index Predicted Replacement rates of ~6.8% in 2021 would be a ~LSD % y/y drag to growth rates. Additionally, given strong growth that persisted late in the year, we estimate that COVID-19 inventory planning pulled forward significant purchases from 2021 into 2020.

Figure 76: JPM Index Implied Replacement versus Actual Replacement



Source: AHRI, Thomson Reuters University of Michigan, BLS, NAR, J.P. Morgan estimates

Table 40: JPM HVAC Replacement Economic Index

	Replacement as % of installed base	Consumer Confidence	Unemployment Rate	Existing Home Sales	JPM Index Predicted Replacement
1989	6.3%	92.8	5.3		7.0%
1990	5.1%	81.6	5.6		6.3%
1991	5.7%	77.6	6.9		5.5%
1992	4.9%	77.3	7.5		5.1%
1993	5.4%	82.8	6.9		5.7%
1994	6.6%	92.3	6.1		6.6%
1995	6.6%	92.2	5.6		6.8%
1996	6.9%	93.6	5.4		7.0%
1997	6.0%	103.2	4.9		7.7%
1998	6.8%	104.6	4.5		8.0%
1999	6.9%	105.8	4.2	5.172	6.6%
2000	7.3%	107.5	4.0	5.188	6.7%
2001	6.6%	89.2	4.7	5.327	6.2%
2002	7.0%	89.6	5.8	5.657	6.3%
2003	6.8%	87.6	6.0	6.176	6.6%
2004	7.4%	95.2	5.5	6.727	7.2%
2005	9.0%	88.6	5.1	7.076	7.3%
2006	6.3%	87.3	4.6	6.516	7.0%
2007	5.9%	85.6	4.6	5.041	6.0%
2008	5.3%	63.8	5.8	4.106	4.7%
2009	5.0%	66.3	9.3	4.329	4.5%
2010	5.2%	71.8	9.6	4.181	4.6%
2011	5.5%	67.4	8.9	4.277	4.6%
2012	5.4%	76.5	8.1	4.652	5.1%
2013	5.8%	79.2	7.4	5.074	5.5%
2014	5.7%	84.1	6.2	4.923	5.7%
2015	6.3%	92.9	5.3	5.234	6.2%
2016	6.1%	91.8	4.9	5.440	6.3%
2017	6.2%	96.6	4.3	5.510	6.6%
2018	6.6%	98.3	3.9	5.340	6.5%
2019	6.5%	96.0	3.7	5.330	6.5%
2020	7.3%	81.5	8.1	5.660	5.9%
2021E	6.9%	85.0	5.2	6.509	6.8%
Correlation		66%	58%	83%	85%*

Source: AHRI, Thomson Reuters University of Michigan, BLS, NAR, J.P. Morgan estimates. *Note: Correlation from 1999-2019.

2020 a cycle within a season...

Coming into 2020 we expected to see the continued slowdown in new units shipped and replacement, expecting LSD growth for the year as the beginning of the cycle began. This underlying trend has since been impacted by COVID-19, and with the data coming in fast and varied, it was a volatile year. Initial reactions in 1Q were for extreme losses, upwards of 20% y/y declines in 2Q and continued depression through the year. With so much uncertainty around consumer behavior, timing of the recovery, and political reaction and regulation, it was difficult for analysts and management teams alike to speak with any certainty, but what was expected was that COVID-19 was going to exacerbate an already slowing cycle. With more clarity now, and the 2Q trough and 3Q rebound in the rearview, 2020 came in at +11%, with add-on/replacement at LDD growth as well, far better than initial expectations when COVID-19 first hit the US markets where companies were calling for mid-teen declines in 1H.

...2021 will be a tale of two halves, annual range of +MSD to -HSD

We show below how we peg our range of scenarios taking into account ongoing volatility around growth comparisons which will be favorable in 1H and then highly unfavorable in 2H, one of the greatest instances of volatility we have seen on record. Using LII and WSO as a gauge, we show below a chart with normal seasonality, and we base our general forecast on more normal buying behavior. We note that with Carrier guiding for 30%+ growth in 1Q suggests material pre-season channel loading.

Table 41: Seasonality Proxies...

	1Q	2Q	3Q	4Q		1Q	2Q	3Q	4Q
Industry Units	21%	35%	27%	17%	y/y	38%	64%	-22%	-17%
LII normal	20%	33%	28%	19%		-7%	44%	-7%	-16%
WSO normal	20%	28%	29%	23%		-5%	41%	4%	-22%
CARR (e)	"low 20s"	"Low 30s"	"high 20s"	"low 20s"					
Industry Units '20	21%	27%	31%	21%					

Source: J.P. Morgan estimates, Company data, AHRI.

We use two methods, using AHRI data to compare what "should have been" versus "what was" to show below the potential overhang heading into '21 and ultimately what shipments should look like. We look back at 2018 as a base that looks seasonally normal when compared to the above. In the first exercise, we use normal q/q trends starting in 1Q19 and play it through, showing limited difference in what should have been versus what was the divergence is more material in 2020, and at the end of the year shows an over-shipment of ~81k units or about 1% of what demand would be if this normal seasonal trend continued, and suggests that, without that overhang, y/y growth should be ~5%. We then show below what would have been implied on a mere 3% growth rate, about in line with the installed base, which calculates a more material 550k units or 6% of what demand should be based on the 3% trend line, though this suggests a y/y decline. Keep in mind that the economic indicators are net negative when compared to 2019 so we tend to take the more cautious approach. In the first approach we would see 1H grow by 20-25%, with a 10-15% decline in 2H while in the second approach we would see 1H up 10-15% with a 2H down 15-20%.

Table 42: Normal Sequential Seasonality, Implies ~4% Industry Growth...

units in 000s

	2018	2019	2020	2021E	2021E Post Inv Impact
Should be	8,021	8,247	8,899	9,537	
		3%	8%	7%	
Was	8,021	8,161	9,066	9,537	9,456
		2%	11%	5%	4%
Over/(under) stock		(86)	167		
Cumulative			81		
% of Annual			1%		

Source: AHRI.

Table 43: ...But Assuming 3% Trend Line Suggests a Correction

units in 000s

	2018	2019	2020	2021E	2021E Post Inv Impact
Should be	8,021	8,261	8,509	8,764	
Was	8,021	8,161	9,066	8,764	8,307
		2%	11%	-3%	-8%
Over/(under) stock		(100)	557		
Cumulative			457		
% of Annual			5%		

Source: AHRI.

Upside Case: Housing Bubble Becomes a Replacement Bubble as Pent-Up Demand Reaches Late Innings

In this section, we evaluate potential upside to our forecast for 2021. The two most impactful elements of a bull thesis supporting upside to this number are: 1) the housing bubble of ~15 years ago turning into a replacement bubble and 2) ongoing pent-up demand from repaired units during the recession, though it is our view that this is now later innings. We walk through our math for each below, but all-in we see an upside scenario of MSD+ HVAC shipment growth for 2021, above our base case estimate for slight declines. To summarize the sections below, we assume normalized industry growth is ~2-2.5%, with theoretical upside to ~HSD % growth from these two drivers. Our upside case dials in only ~half of this potential upside, and base case dials in none of it, and includes drags from non-repeat of the macro disconnect and COVID-19 inventory planning that favorably impacted 2020 growth. High level, we see that upside exists, but the industry has had a strong run through this cycle and we feel more comfortable with a more conservative base case forecast as we believe the pent-up demand story and replacement bubble tailwinds are mostly done at this point.

Table 44: JPM Upside Case Summary- 2021

%	
Normal Installed Base Growth (2003-2020)	~2.3%
"Replacement Bubble" Upside (2021)	2.0%
Remaining "Pent-Up Demand" Upside (2021)	0%
Annual Replacement Growth Upside Case	~4.3%
Annual Housing Growth (JPM Base Case)	13%
Annual Replacement Growth (Upside Case)	4-4.5%
Annual Total Shipment Growth (Upside Case)	~5.5%

Source: J.P. Morgan estimates

Table 45: JPM Base Case Summary- 2021

%	
Normal Installed Base Growth (2003-2020)	~LSD %
"Replacement Bubble" Upside assumed in base case (2021)	0%
Remaining "Pent-Up Demand" Upside in base case (2021)	0%
Annual Replacement Growth Base Case	~LSD %
Less: non-repeat macro disconnect (stimulus/work from home)	(3%)
COVID-19 inventory planning headwind	(3.5%)
Annual Replacement Growth, Net	(~MSD %)
Annual Housing Growth (JPM Base Case)	~LT %
Annual Replacement Growth (Base Case)	(MSD %)
Annual Total Shipment Growth (Base Case)	(LSD %)

Source: J.P. Morgan estimates

Pent-up demand from '08/'09 downturn now mostly satisfied

The resi HVAC market experienced sharp declines following the peak in 2005, continuing through the housing decline and subsequent recession, and then realizing sluggish growth following the recession as consumers opted for repairs over replacements. A key part of the thesis to outgrowth in this market over the last few years has been the release of this pent-up demand from the ~5 years of depressed market levels. We see this trend declining, with most of the pent-up demand units now satisfied. This said, after negative responses around pent-up demand in the 2019 survey, responses this year indicated a reversal here, with more distributors indicating they are seeing an increase in pent-up demand. This, however, is likely a function of the weak April/May and not an actual longer-term trend, which indeed was satisfied in 2H20.

We view HVAC as a non-discretionary purchase that consumers would have a hard time living without, and although they can push off replacement through repair activity in the short term, they will eventually need to replace their systems. That said, we see the repair vs. replace dynamic shifting to pre-2012 status, with customers opting to repair and not replace units given the uncertain economic environment, which also puts additional pressure on the pent-up demand theory continuing. Looking at the past few years, as replacement demand has come back, much of this pent-up demand has already been realized; so, the key question becomes how much demand is still left over and how much demand will be helped by COVID-19 backlogs versus diminished by the shifting repair vs. replace dynamic. In order to estimate this, we use 2004 as a baseline (2005/06 were impacted by 10 SEER pre-buy) and apply a 2.25% normalized CAGR (in line with 15-year installed base growth from 2004-2019) to the base through 2020 to determine how much a normal level of demand would have been through this timeframe. We then compare to actual 2020 demand levels and come up with an estimate. In prior years this has remained a positive driver of upside potential, but we now see the story as mostly satisfied. We summarize our math below and note that we calculate pent-up demand purely from a replacement unit perspective, rather than the overall market, as while there likely is still some pent-up housing demand in the system, new construction units can move independently with fluctuations in the market for new homes.

Table 46: We Estimate ~30K Units of Pent-Up Replacement Demand

# units	
2004 Add-on/Replacement Demand	5,280,835
2020 Add-on/Replacement Demand @ 2.25% CAGR	7,539,033
2020E Add-on/Replacement Demand	7,660,285
"Pent-up" Demand	0

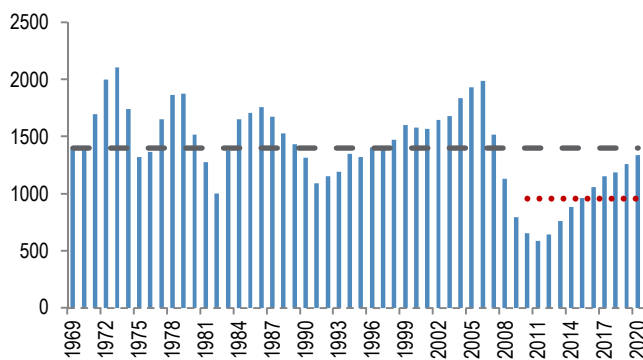
Source: AHRI and J.P. Morgan estimates

Housing bubble of last decade becomes a replacement bubble: now in late innings of this impact

Conventional wisdom is that the housing bubble from the early 2000s will create an echo boom for replacement demand. This means that peak housing completions from the 2002-2006 period should drive replacement demand growth to be above normal through at least 2021, considering the average life of a system in the 15-year range. We agree with this, and walk through our math below, but note that like the pent-up replacement demand analysis above, this should be in its later innings. Overall we've calculated ~2mm units of theoretical opportunity here over five years (starting in 2016), or ~5% annual upside to normalized replacement growth out to 2021. Note that we see caveats to this analysis, discussed further below, and don't dial the full amount into our combined upside case.

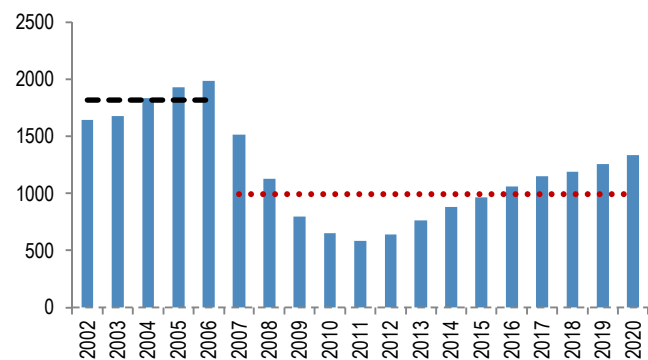
First, we look back at housing trends over the past few cycles, highlighting two key points: 1) from 1968-2020 the average number of housing completions per year was ~1.4mm, and 2) housing completion growth averaged ~5% per year during the boom in 2002-06 with an average of ~1.8mm per year. We note that housing completion growth of ~5% per year from 2002-06 lagged housing start growth of ~7% per year during the same time period, but we use housing completions in our analysis because HVAC systems typically go in towards the end of the construction process. While there is a debate to be had over whether 1.4mm units is a fair normalized level of housing completions annually going forward, this is a longer-term concern for resi HVAC and does not have an impact on the fact that the early 2000s saw above normal housing activity, which should invariably lead to above average replacement activity (~85% of the overall market).

Figure 77: LT Housing Completions Have Averaged ~1.4mm per Year
Thousands of units



Source: US Census

Figure 78: 2002-06 Housing Completions Averaged ~1.8mm per Year
Thousands of units



Source: US Census

Based on the above data, housing completions during the 2002-06 boom were ~400K above normal per year. Given that HVAC units typically last about 15 years, simple analysis would indicate that an incremental 400K units per year will be coming up for replacement (unit breaks) over a 5-year period which we assume began in 2017. Assuming that ~15% of these unit breaks get repaired instead of replaced, this indicates ~5% of annual replacement growth upside above and beyond the normalized level of replacement that would be expected by LSD type growth in the installed base going forward.

Table 47: The "Replacement Bubble" Could Theoretically Add ~5% to Annual Replacement Growth

Units and %	
2002-06 Annual Housing Completions	1,800,000
LT Average Housing Completions	1,400,000
Incremental Replacement Opportunity (Annual)	400,000
Incremental Replacement Opportunity (5 Year)	2,000,000
2020 Base Replacement/Add-Ons ex-COVID-19 inventory planning units	7,410,285
Annual Replacement Opportunity (Unit Break) Upside	5.4%
Annual Replacement Growth Upside (assume 15% units repaired)	~5%

Source: US Census and J.P. Morgan estimates

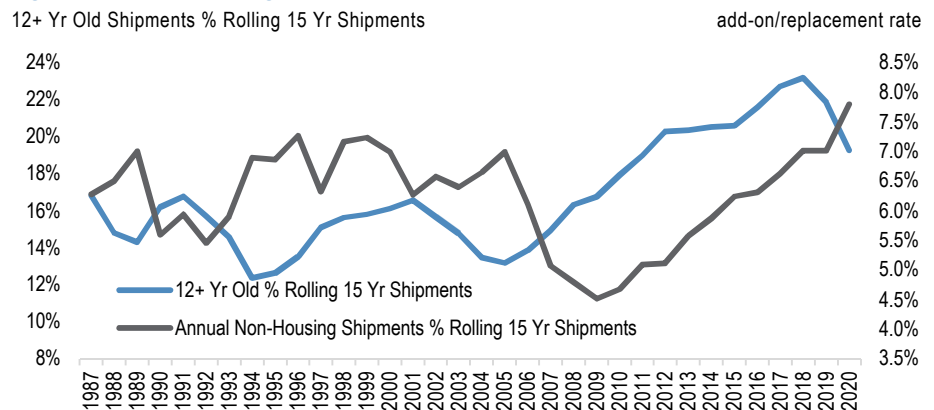
HOWEVER, despite the lofty upside case laid out above, we caution that it is exceedingly difficult to quantify the age of the installed base or the number of units reaching the end of their useful life. The most intuitive approach that we have used in the past is to take an assumed useful life of the unit (say, 10-15 years) and treat all historical shipments from 10-15 years ago as the "replacement pool." There are a few problems with this approach, however, including:

- *Demolished or vacant units*—Just because a unit was shipped doesn't mean it is still in use today. The home using that system may have been demolished or vacated, and there is no practical way to identify the age of units taken out of service. We also estimate as many as 5 million units historically shipped to mobile/manufactured homes, many of which may no longer be in use.
- *Mixing effect*—There is a fairly wide range of estimates of a system's useful life, with systems in warm climates often breaking after 10-12 years but cooler climate systems lasting as much as 20+ years. There is also unit-specific variance, with some units getting replaced early due to unusual circumstances and others lasting much longer than normal. Frost & Sullivan estimated that ~80% of replacements are made for "end of life reasons."
- *Differences in utilization*—In recent years an increasing number of systems have been sold into seasonal homes, for example, which are not necessarily running year-round. Similarly, a second condensing unit in the same home may not be required to operate at the same intensity of a single unit.
- *Limited historical correlation between installed base age and replacement rate*—On an intellectual level, it makes sense to assume that as the installed base ages, the replacement rate should go up due to more unit break opportunities. We agree with this logic, and it makes sense to us, but examining historical correlation between installed base age and replacement rate shows only a limited correlation. This makes some sense given replacement rates, including willingness for add-ons, can change quickly depending on fluctuations in the consumer economy, while the installed base age is more static. Indeed, 2007-2009 shows a clear divergence, with an uptick in replacement age units corresponding with a sharp

downtick in replacement rate. On the whole, however, there does seem to be some correlation here in more normal economic environments.

By the time all these factors interact, we think the “replacement pool” gets blurred to the point that looking at small pockets of historical shipments is less useful as an indicator of replacement demand. Indeed, if we were to run this analysis using (for example) 14- to 16-year-old shipments as our replacement pool, the analysis would tend to be skewed by the denominator (or short-term changes to the installed base). In our view, this doesn’t seem logical, making us reluctant to dial in the full upside from the scenario outlined above. This said, age of the installed base (12+ Yr Old Shipments as % of Rolling 15 Yr Shipments) does appear to be a good leading indicator for add-on/replacement rates, which we will discuss a bit more below.

Figure 79: Installed Base Age vs Replacement Rate



A look at regional impacts: Stepping back into the discussion of useful life, we note that the useful life of an HVAC system can vary by region, as units in the South should logically be running more often and will not last as long as units in colder climates, and we look at sensitivities to useful life below. To level set before getting into the analysis, we note that the Southeast and Southwest account for a bit over half of industry shipments, which does not include any southern portion of the Central or Western regions.

Figure 80: Industry Shipments by Region

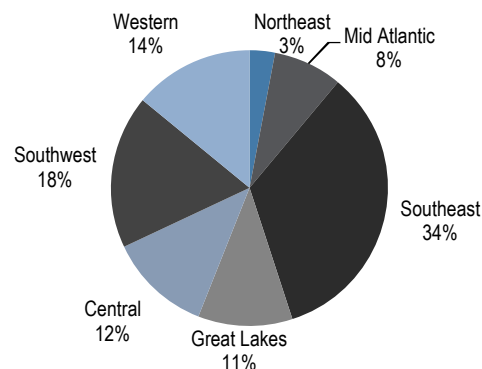
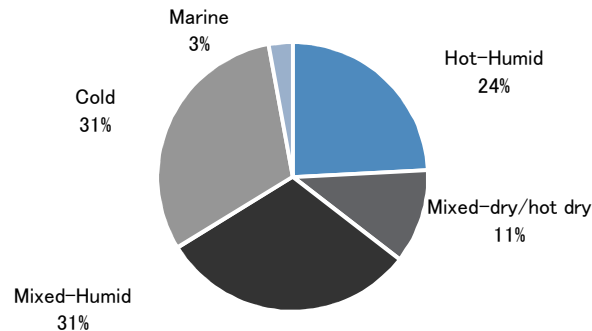


Figure 81: Geographic Breakout of Homes With Central AC (2015)



Source: EIA.

Of note, going back to the housing boom from the early to mid-2000s, we also see that replacement rates were driven disproportionately by the South as shown below. Looking at housing completions, 2002-06 saw ~400K per year above the long-term average. Regionally, the Northeast was slightly above historical averages, while the Midwest was ~80K above LT average, the South was ~220K above LT average, and the West was ~125K above LT average. In other words, the South drove a bit more than half of the "housing boom."

Table 48: The South Accounted for Over Half of the Housing Boom from 2002-06

Thousands of Housing Completions

	Northeast	Midwest	South	West	Total
LT Avg Annual Housing Completions	149	261	627	341	1,379
2002-06 Avg Annual Housing Completions	162	340	849	465	1,816
Avg Annual Difference	13	79	222	124	437
Total Difference	63	395	1,110	620	2,186

Source: US Census and J.P. Morgan estimates

The reason we highlight the South here is that if we assume the useful life of a system in the South is less than 15 years, this means that much of the "replacement boom" laid out above may have already been realized over the past several years. We look at the sensitivity to useful life below, assuming a useful life ranging from 10-15 years (we simply assume all above normal housing completions from the South in each year from 2002-06 get replaced anywhere from 10-15 years later). If we assume a 15-year life, we get to the same ~2mm unit opportunity outlined above. If we assume a 10-year life, this means all housing boom units from the South were already replaced by 2016 (2006 + 10 years = 2016 in a simplified case). However, even under this scenario, we would assume that units in the Northeast, Midwest, and West last 15 years or more, so we would still see the replacement boom opportunity in those regions, getting us to a scenario with close to 1mm units of opportunity.

Table 49: Housing Completions in the South: 2002-06 vs Long-Term Averages

Thousands of Housing Completions

	South Completions	LT Avg	Difference
2002	758	627	131
2003	755	627	128
2004	841	627	214
2005	903	627	276
2006	987	627	360

Source: J.P. Morgan estimates

Table 50: Replacement Boom Upside Sensitivity to Avg. Life of Unit in South

Thousands of Units (assume 85% incremental units get replaced)

Avg. Life of Unit in South	Incremental Replacement Opportunities	Annual Upside (2021)
15 Years	2,000	4.6%
14 Years	1,869	4.3%
13 Years	1,741	4.0%
12 Years	1,527	3.5%
11 Years	1,250	2.9%
10 Years	890	2.0%

Source: J.P. Morgan estimates

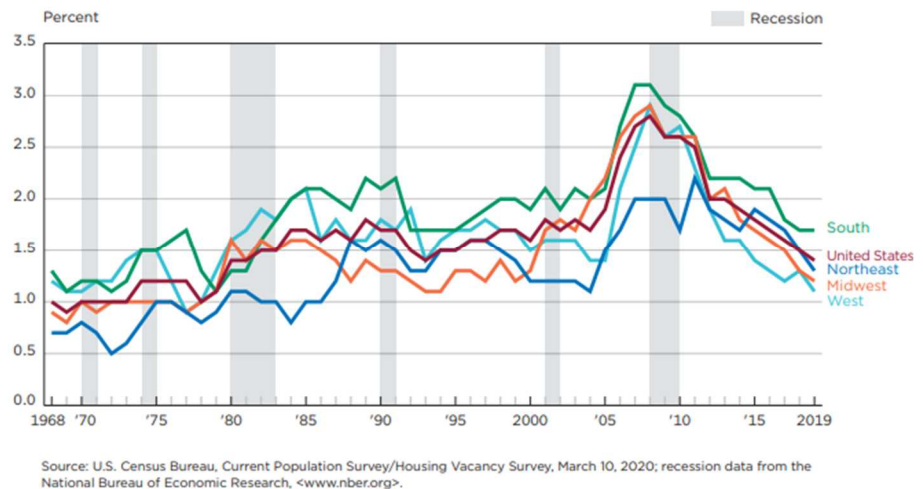
Clearly, quantifying the potential upside from a replacement boom is difficult and requires some finesse, with our analysis here indicating a range for total units of 900K (~2% upside) to 2mm (~5% upside). We think based on the regional analysis, it is likely that much of the upside in the South has been captured in the past several years (though units likely last beyond 10 years on average even in the South). Additionally, we think factors like vacancies and limited historical correlation between installed base age and replacement should keep us conservative in dialing in potential upside.

Therefore, and considering the next year forecast is now 2021, we are dialing in only ~2% annual replacement boom upside into our upside case, at the low end of our calculated potential range of 2-5%. We think this is appropriately conservative, while still reflecting some upside from what could be a positive fundamental tailwind for another year or so.

Abandoned home rates are also high relative to history

We also caution that homeowner vacancy rates remain high relative to history, even following recovery from the recession. Looking at the chart below, homeowner vacancy rates have generally increased from 1968 onwards, with spikes during recessionary periods, but even with the recovery following 2009 absolute vacancy levels are still higher than at any point prior to 2004 (recessions included). To us, this seems to indicate that the housing stock was overbuilt last cycle, which is not a surprise or new news, but does help explain why the housing recovery has been more muted/steady than some expected over the past few years. While the simple math indicates an opportunity of ~2mm units from the housing bubble that could be realized in the 2017-2021 period, it's likely that some of these houses are no longer being used, which, combined with the demographic headwinds related to structurally lower household formation among millennials, keeps us relatively conservative by only dialing in a portion of our upside case.

Figure 82: Annual Homeowner Vacancy Rates for US by Region



Putting it together: pent-up demand and the replacement bubble could drive upside for another year but these factors close to fully satisfied

Taking the above analysis and summarizing it, we see a minimal amount of remaining pent-up demand units left in the system, with the industry also in late innings of the ~2mm units of (theoretical) incremental replacement opportunity from the replacement bubble. Assuming our base case for housing completions growth of ~low teens % for next year is fair, and replacement accounts for ~85% of industry shipments, this implies an upside case for industry shipment growth of close to 6%, following the stronger than expected 2020 that was boosted by a temporary disconnect from the macro related to stimulus/work from home/weather. This is above the normalized installed base growth of +LSD, and our base case for LSD declines, which doesn't give credit for potential upside from these two factors, and includes a drag from non-repeat of the macro disconnect in 2020. We believe this will be followed by a strong 2022 up in the HSD % range, followed by LSD declines in the subsequent years, meaning a flattish market for replacement/add-on units over the 2019-2024 period, but with plenty of volatility.

Table 51: JPM Upside Case Summary- 2021

%	
Normal Installed Base Growth (2003-2020)	~2.3%
"Replacement Bubble" Upside (2021)	2.0%
Remaining "Pent-Up Demand" Upside (2021)	0%
Annual Replacement Growth Upside Case	~4.3%
Annual Housing Growth (JPM Base Case)	13%
Annual Replacement Growth (Upside Case)	4-4.5%
Annual Total Shipment Growth (Upside Case)	~5.5%

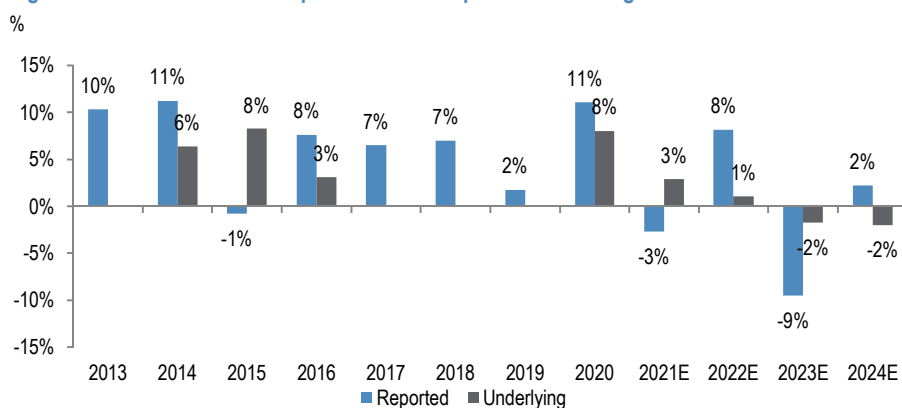
Source: J.P. Morgan estimates

Table 52: JPM Base Case Summary- 2021

%	
Normal Installed Base Growth (2003-2020)	~LSD %
"Replacement Bubble" Upside assumed in base case (2021)	0%
Remaining "Pent-Up Demand" Upside in base case (2021)	0%
Annual Replacement Growth Base Case	~LSD %
Less: non-repeat macro disconnect (stimulus/work from home)	(3%)
COVID-19 inventory planning headwind	(3.5%)
Annual Replacement Growth, Net	(~MSD %)
Annual Housing Growth (JPM Base Case)	~LT %
Annual Replacement Growth (Base Case)	(MSD %)
Annual Total Shipment Growth (Base Case)	(LSD %)

Source: J.P. Morgan estimates

Figure 83: Total Resi HVAC Shipment Growth Expectations Through 2024



Source: AHRI and J.P. Morgan estimates

One more caveat: extended unit life and warranty dynamics could extend cycle

At the risk of muddling the calculations around the length of the cycle further, we note here that there has been increasing talk throughout the channel on longer unit life, driven by increased quality of manufacturing and better contractor performance/education, which is allowing for extended warranties. While difficult to validate empirically, and a source of some level of disagreement among key players on whether units truly are lasting longer (TT management has seemed most bullish), we note that if units are lasting a couple of years beyond the 12-15 year timeframe, this could represent upside and a more extended cycle for residential HVAC. Indeed, in our upside scenario above, we are only dialing in about one-third of the potential upside from the housing replacement echo boom as we assume some of this has already come through in key southern regions. However, if units truly are lasting longer, this could indicate that most of the upside seen over the past several years has been almost entirely driven by the pent-up demand dynamic coming out of the recession, and the bulk of the housing echo boom upside would still be to come, likely extending the length of the cycle and leading to above average growth out past 2020. While this is not our base case, our channel checks do provide some level of support for units lasting longer, which we think is a decent qualitative indicator that there could be something to the idea that the upcycle may last longer than our base case. We also note that this would diminish the impact of a potential downside scenario (explored in the next section), where the housing downturn and sluggish recovery potentially create a replacement vacuum (the inverse of the echo boom discussed above) beginning in the early 2020s. Neither the full upside or downside scenarios discussed above and below are our base case, but extended warranty dynamics and channel buzz around longer unit life do provide support for the idea of a more extended HVAC upcycle with a relatively smooth trajectory that is unlikely to fall off a cliff in the intermediate term, in our view. We did some channel checks through the distributor network and asked whether unit life has been extended for more recent products, and most responded that it has. Some items that stood out consistently in our feedback as a source of extended unit life were improved compressor technology (scroll), contractor education, and improved equipment sizing.

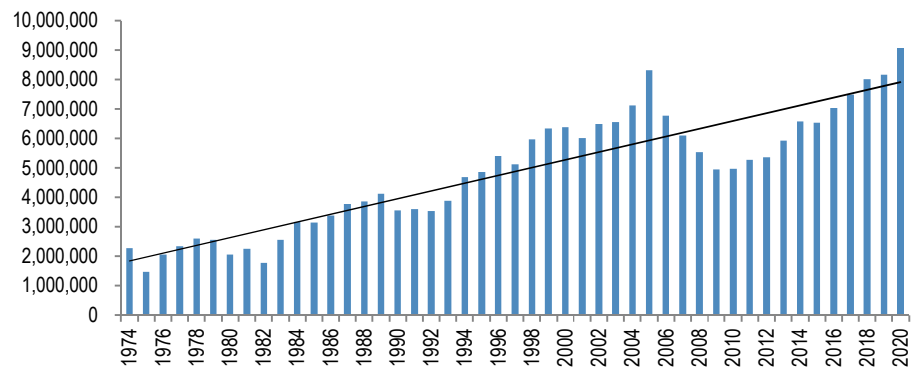
Downside Case: After Better Than Predicted '20, Market Recouples to Macro Drivers

Market returned to trend line, '20 should have been worse, what if the market recouples to the macro?

2018 and 2019 put us past trend line for residential HVAC, and though 2020 started off relatively weak, it came back strong and finished well above trend, at up ~11%. The next few years should be volatile but vs. '19 we see flattish replacement/add-on volumes (non-housing) through '24, with a down '21. Stubbornly weak macro indicators, however, suggest there is also downside risk to that forecast. We had historically considered downside to housing in this analysis but in the intermediate term see this as being offset by low interest rates and perhaps a bit of de-urbanization, so we focus on the replacement rate.

Figure 84: Overall Residential HVAC Market Regained Trend Line in 2017 and Is Now Above Trend Line

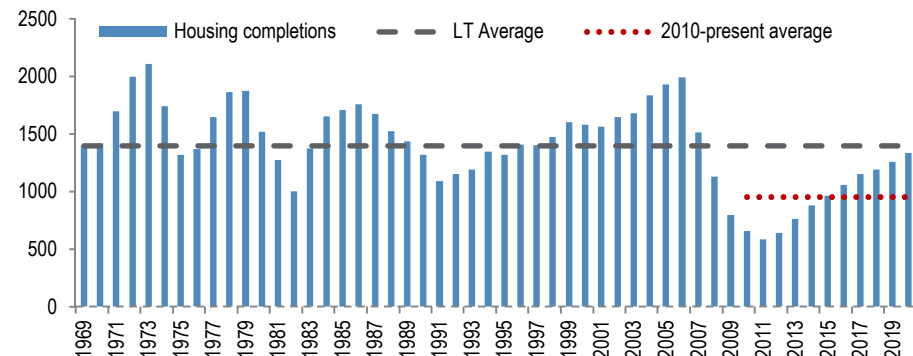
Units



Source: AHRI and J.P. estimates

Figure 85: ...But Housing Completions Still Below Normalized

Thousands of units



Source: US Census

In terms of replacement rates, as we walked through above, we think this is ultimately driven by existing home sales, consumer confidence, and employment. Below we present a matrix of reasonable downside outcomes for each of these indicators, and plug into our model to determine an implied replacement rate in each scenario. Looking at the implied replacement rates in each scenario and comparing to

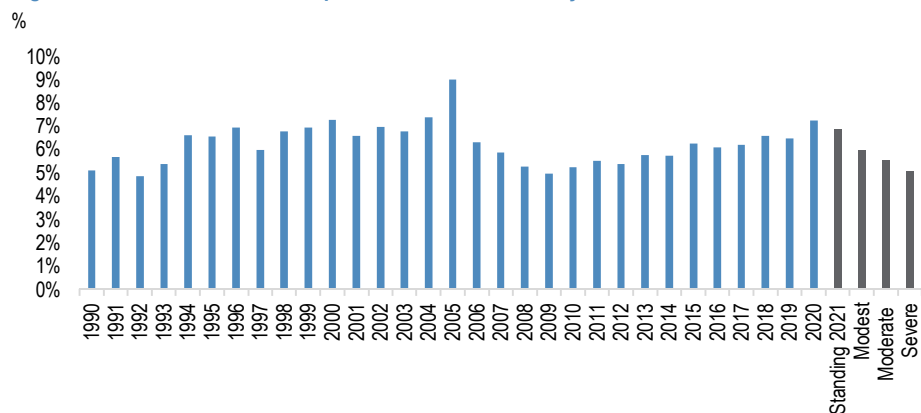
prior cycles indicates that the "modest" downside scenario would represent a minor pullback, while a "moderate" scenario would represent more of a correction back to replacement levels seen earlier in the cycle when replacement was just beginning to recover. Our "severe" downside scenario doesn't quite get back to the <5% replacement rate we saw at the depth of the downturn in 2009, which we think is probably a bit too draconian, but falls closer in line with still depressed levels seen from 2010-13. We think 2021 could be down ~LDD % in a modest downside scenario and MT % in a moderate downside case.

Table 53: Implied Replacement Rate at Various Downside Scenarios

Scenario	Consumer Confidence	Unemployment Rate	Existing Home Sales	JPM Index Predicted Replacement Rate
Standing JPMe	85	5.2	6.5	6.8%
Modest Downside	80	6.5	5.6	6.0%
Moderate Downside	75	7.3	5.2	5.5%
Severe Downside	70	8.0	4.8	5.1%

Source: J.P. Morgan estimates

Figure 86: Downside Scenario Replacement Rates vs History



Source: J.P. Morgan estimates.

Re-running the math above we did around what a normal trend line should be, and assuming things were to recouple all at once to the indicators, and combining this with the standing inventory overhang versus a market that should have grown 3%, we see an even more severe downside of -25%.

Table 54: Assuming Demand Re-couples to the Indicators Suggests an Even More Meaningful Correction

units in 000s

	2018	2019	2020	2021E	2021E Post Inv Impact
Should be	8,021	8,261	7,022	7,233	
		3%	-15%	3%	
Was	8,021	8,161	9,066	7,233	6,776
		2%	11%	-20%	-25%
Over/(under) stock		(100)	557		
Cumulative			457		
% of Annual			5%		

Source: AHRI.

Post normalization risk: 2007 housing downturn and sluggish recovery could create a soft pocket for replacement opportunities beyond 2020

Our standing base case for our residential HVAC model is that replacement+add-on demand (non-housing) will remain flattish from 2019 through 2024, as following the early 2000s housing bubble and release of pent-up demand from the recession through 2020, the market should logically revert back to a normalized run-rate and grow in line with the installed base (+LSD). However, we do think there could be risk to this assumption as the opposite dynamic of the “replacement bubble” starts to layer in, meaning less units will potentially be coming up for replacement given the housing market crash in 2007 and subsequent sluggish recovery. Mirroring our upside case from above, where we noted that 2002-06 saw 1.8mm housing completions per year on average versus historical averages of 1.4mm, 2007-20 has seen ~1mm completions per year on average. Setting this against our base case market unit growth out to 2024, this differential could represent up to ~6% headwind from fewer replacement opportunities given the lower amount of housing stock put in place during the recession. To be clear, we don’t think this is appropriate as a base case. Indeed, in our upside case above, we are only dialing in about two-thirds of the potential upside from a replacement bubble, and implicitly dialing in less than half in our base case, so if the hypothetical downside here eventually comes through in full, it could be accompanied by materially higher upside for the next few years. The more likely scenario, in our view, is a more steady and smooth progression where less of the upside than the math suggests from the replacement bubble is realized near term, while less of the potential downside from the housing recession is realized longer term. Our base case is now flattish growth for the next few years, but with volatility in between including a down 2021, up 2022, down 2023, and LSD growth in 2024.

Table 55: Housing Recession Could Drive Downside in Replacement Opportunity Post 2021

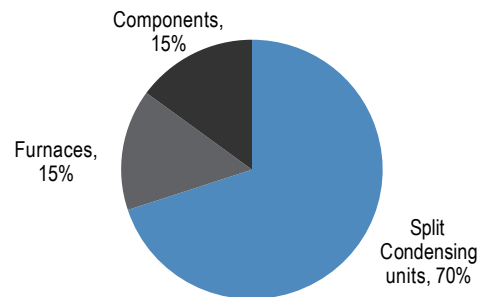
2007-20 Annual Housing Completions	994,271
LT Average Housing Completions	1,397,951
Incremental Replacement Opportunity (Annual)	(403,679)
2021 Base Replacement/Add-Ons	7,234,388
Annual Replacement Opportunity (Unit Break) Downside	-6%

Source: J.P. Morgan estimates

Resi HVAC Industry Revenue Model

With a view on unit growth for A/C and condensing unit shipments, we then combine these to drive our industry revenue model. The key remaining variables are (1) mix, or the proportion of high-efficiency units sold; (2) furnace sales; (3) component sales; and (4) price increases on like-for-like units. Recall that while condensing units drive the majority of industry revenues, we estimate that furnaces and components make up a combined ~30% for most OEMs.

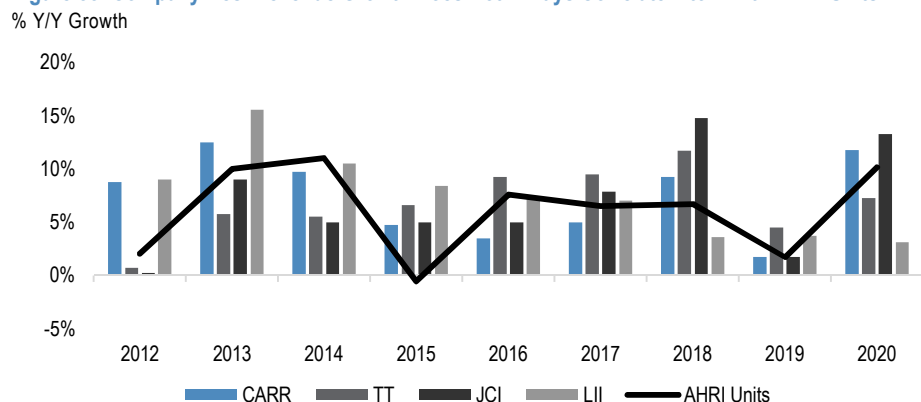
Figure 87: HVAC Industry Approximate Revenue Mix



Source: J.P. Morgan estimates.

Indeed, a look at company revenue performance over the last several years suggests that cooling unit growth alone does not tell the entire story.

Figure 88: Company Resi Revenue Growth Does Not Always Correlate 1-to-1 with AHRI Units



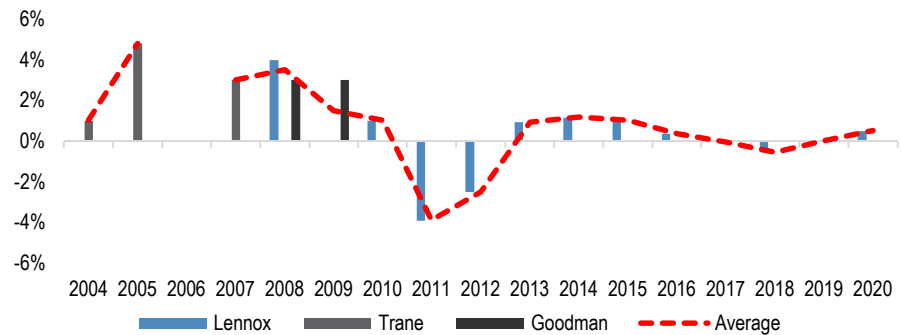
Source: Company reports, AHRI, J.P. Morgan.

We assume mix is slightly positive on steady mix up to higher efficiency units

On top of changes in volume (units), the mix dynamic is primarily related to the number of high-efficiency systems sold. The higher SEER systems will sell at a higher price, typically around 10% per SEER rating. Some of this value is passed on to suppliers in the form of higher component costs (i.e., high-efficiency motors/compressors), but we estimate ~75% of the incremental revenues from favorable mix flows through to OEM profits/margins. While disclosures on mix have been inconsistent over the years, we note that the average reported mix benefit to the OEMs 2004-10 (excluding the 13-SEER transition) has been ~3%. Since then, we estimate mix as an average ~3% negative in 2011-12, turning modestly (~1%) positive in 2013-16, about flattish in 2017-2019, and slightly positive in 2020.

Figure 89: Mix Averaged ~3% per Year for the OEMs 2004-2010, Negative in 2011-12, Modestly Positive in 2013-16, Flattish in 2017-2019, Up A Bit in 2020

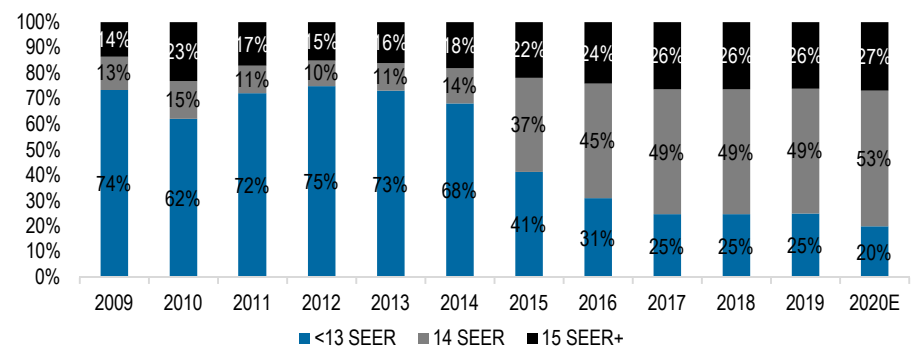
% Sales Contribution From Mix



Source: Company reports

Looking back on this cycle, between 2010 and 2012, 13 SEER had steadily gone up in the mix, reflecting: (1) the reduction in efficiency tax credits, (2) the return of R-22 dry ships, which is almost exclusively a 13 SEER product, and (3) the greater share of 13 SEER in residential new construction. In 2013 and 2014, however, this trend reversed with most players reporting modestly positive mix. There is no definitive data on SEER mix, but we estimate that 13 SEER dropped ~2 points y/y, reflecting a healthier consumer more willing to buy non-entry level products. In 2015, the new 14 SEER minimum efficiency regulations drove a significant mix shift away from 13 SEER, and we estimate that 13 SEER's share of the market went from ~70% in 2014 to ~40% in 2015 and ~30% in 2016. The industry saw strong mix benefits in 2015-16 from this transition, which faded in 2017 as the 13 SEER transition had largely played out, though there remains ongoing mix up to higher efficiency products 15 SEER and above which we think continues into the future.

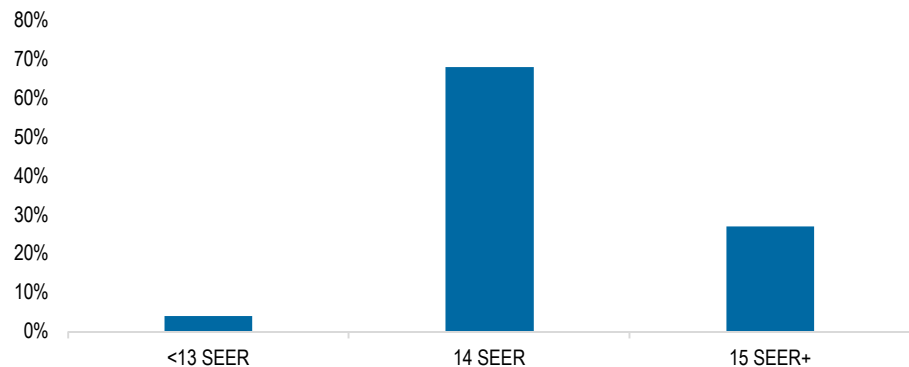
Figure 90: Condensing Units Mix by SEER (JPM Estimates)



Source: Company data, J.P. Morgan estimates.

Commentary from Emerson on SEER offerings and the breakdown point to a similar story with even a lower percentage of low SEER productions and similar 15+ SEER products.

Figure 91: EMR SEER Mix

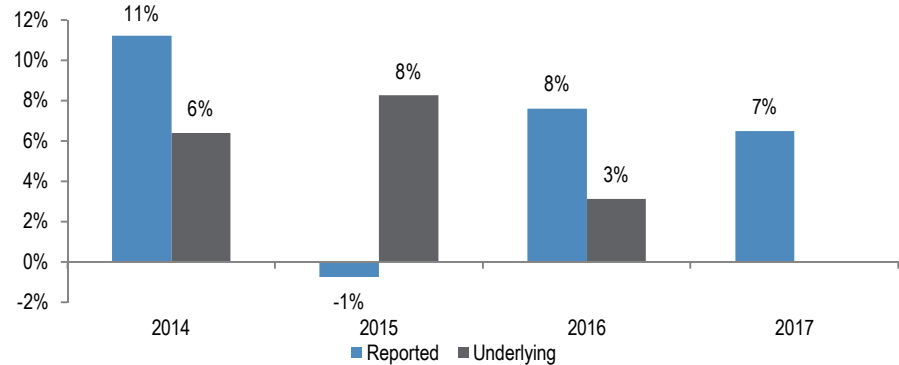


Source: J.P. Morgan estimates, Company data.

14 SEER transition summary: To better understand the 2023 regulations coming to the industry, we look back to 2014/2015 with the last SEER transition below. The HVAC industry underwent a regulatory transition to 14 SEER minimum efficiency at the end of 2015. We believe the transition was a slightly positive event for HVAC OEMs, in line with expectations. In a brief recap of the 14 SEER transition, the proposed standards divided the country into three regions: the Southeast, Southwest, and Northern markets. For furnaces (original target date of May 2013), the DOE was mandating a move to 90% AFUE for the Northern regions (those with >5,000 heating degree days), while the Southeast and Southwest would remain at 80% AFUE. For AC and heat pumps (target date of January 2015), it called for a 14-SEER minimum for the Southeast and Southwest markets. Unlike previous rules, which had prohibited the production of new units, the regional standards would be an installation ban under which it would be unlawful to install equipment that doesn't meet the minimum standards. Following a number of legal challenges to the transition, a settlement was reached with the primary new development being an 18-month grace period for distributors to sell 13-SEER equipment manufactured before January 2015. This created an incentive to pre-build inventory ahead of the 12/31/14 manufacturing deadline, which stands in contrast to the original installation-only ban that applied irrespective of the manufacturing date and therefore created no incentive to pre-build. 13-SEER was 75% of the overall market headed into the transition.

We estimate ~1.1mm units were pre-built, and ~285K units were pulled into 2014 distribution channel as pre-buy. The AHRI shipment results from the last few months of 2014 clearly reflected the impact of 13 SEER pre-buy on the channel. While most major OEMs opted to pre-build 13 SEER and hold the inventory, we estimate that ~285K units were shipped into the distribution channel between September and December, based on an assumption of ~6% underlying growth rate in shipments. Based on industry commentary and OEM inventory builds, we estimate total 13 SEER pre-build at ~1.1mm, meaning ~30% of the pre-built volume was shipped into distribution as pre-buy. These 285K units were pulled into 2014 at the expense of 2015, thus impacting the resulting AHRI y/y growth rates for 2014-16, as shown below. Backing out the impact of pre-buy, we see that "underlying" industry growth was relatively steady over this time at mid to HSD levels, while reported AHRI growth was more volatile due to the impact of pre-buy.

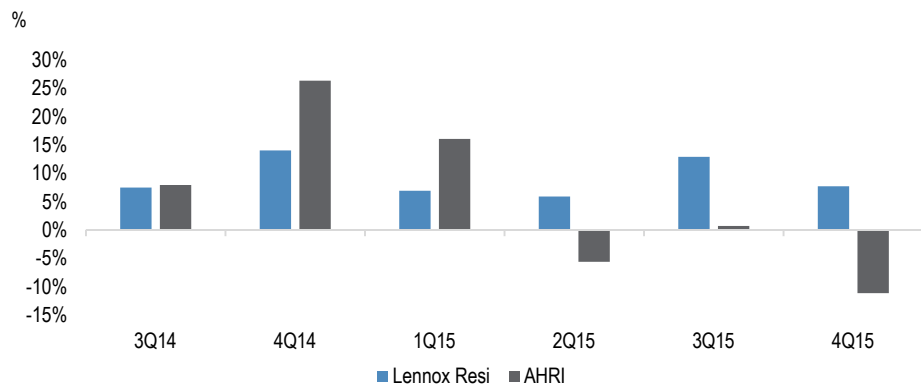
Figure 92: AHRI Reported vs. Underlying (ex pre-buy) Volume Growth Estimates



Source: J.P. Morgan estimates.

Putting the AHRI data together with reports from OEMs, there was an interesting bifurcation between larger and smaller players, as smaller HVAC OEMs disproportionately shipped their 13 SEER products into distribution as pre-buy, while larger OEMs were able to hold the 13 SEER as inventory and ship into distribution as needed during the 2015 selling season. Indeed, we saw little evidence of a pre-buy effect at Goodman, Carrier, Trane, and Lennox, each of which reported solid MSD to HSD growth in 4Q14, in line or slightly above what we estimate as underlying industry growth, with inventory build suggesting more “pre-build” here. While most of the smaller players are private, making specific data difficult to obtain, it stands to reason that with industry shipments up ~20% from September to December and each of the major players reporting MSD to HSD growth rates, the majority of the 13 SEER pre-buy impact came from smaller players. Similarly, most of these major OEMs reported MSD volume growth throughout 2015, including 4Q15, even as reported AHRI shipments declined double digits in 4Q15.

Figure 325: Lennox Resi Organic vs AHRI Shipments



Source: Company reports and AHRI

Modest SEER shift in 2023 should keep mix moving up as a driver of revenue

We think mix has been relatively stable for the past few years, but will take another leg up on the regulatory change coming in 2023. Minimum residential efficiency levels for central ACs under 45,000 Btu/hr would be 14 SEER in the North and 15 SEER in the Southeast and Southwest (versus 13/14 today), and for over 45,000 Btu/hr, would be 14.5 SEER in the Southeast and Southwest, and 14 SEER in the North. Heat pump efficiency levels would be set at 15 SEER for all regions. These new efficiency standards are expected to bring an 8-10% increase in efficiency, while on the commercial side, systems will move to level EL3 (15% increase in minimum efficiency). From a cost perspective, a move up in SEER can add roughly 10% to system cost, but our industry checks suggest this one may be more expensive than the headline SEER implies because the regulators will require new testing procedures.

Table 56: New efficiency standards approved by ASRAC

Product class	National		Southeast		Southwest	
	SEER	HSPF	SEER	SEER	SEER	SEER
Split-system air conditioners with a certified cooling capacity of <45,000 Btu/h	14		15	15	12.2/10.2	
Split-system air conditioners with a certified cooling capacity of > or = 45,000 Btu/h	14		14.5	14.5	11.7/10.2	
Split-system heat pumps	15	8.8				
Single-package air conditioners and heat pumps	14	8.0			11.0	

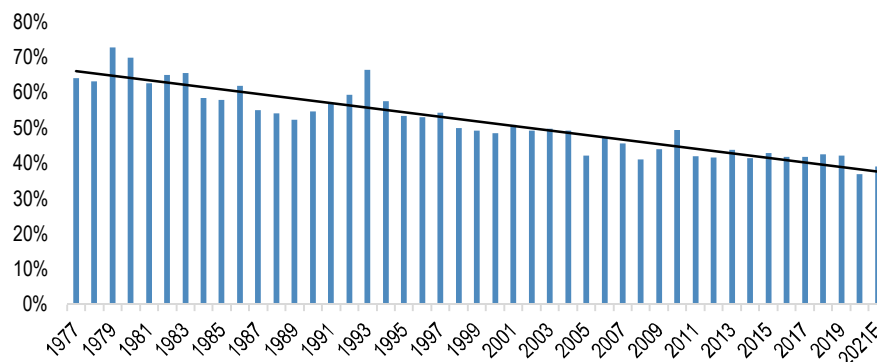
Source: ACHR News

Furnaces should continue steady growth

With useful life of 20-30 years, furnaces have longer life than AC units (12-18 years), and should see a replacement tail extend for a couple years, though as mentioned previously, replacement timing can vary depending on different factors such as geography (a furnace in a cooler climate with high usage rates will likely be replaced earlier) and customer decisions to replace before end of life. In the US, JCI cited furnaces in the North with 15-20 year life, while furnaces in the South would generally last 25+ years. With the housing boom led by the South, Southeast and Southwest where furnaces last longer, they would expect a subsequent furnace replacement bubble to come in later, an event that should occur in the early 2030s, mostly around outdoor units, coil and efficiency changes.

Furnace growth was steady from 2014-2017 in the MSD range, after strong DD growth in 2013 on weather. Growth has varied more recently, up 9% in 2018 and 1% in 2019. Of note, 2019 saw skewed growth as the new FER standard came into effect in July. With the regulation affecting the manufacture of standard units but not their sale, we expected an unusual increase in furnace production in 1H as companies built inventory ahead of the deadline. As a general rule, we expect growth in furnaces to lag that of AC/Heat pumps (heat pumps have gradually displaced furnaces over time, largely in warmer climates). Furnace units were down 3% in 2020, and we model +3% in 2021 which would bring the ratio of furnaces to AC/HP shipments in line with its long-term trend.

Figure 93: Ratio of Furnace Shipments to AC/Heat Pump Shipments



Source: AHRI, J.P. Morgan estimates.

Total industry revenue CAGR of ~1% 2020-2024

The model below builds up the various drivers of industry revenues, including split systems, furnaces, and indoor components. We expect revenues to outpace underlying AHRI cooling shipments by ~1.5% on better price as well as positive mix. This brings us to a ~1% industry revenue CAGR from 2020 through 2024.

Table 57: JPM HVAC Industry Residential Equipment Revenue Model

	2013	2014	2015	2016	2017	2018	2019	2020	2021E	2022E	2023E	2024E
Splits Units, Y/Y	10.3%	11.2%	-0.7%	7.6%	6.5%	7.0%	1.8%	11.1%	-2.7%	8.2%	-9.5%	2.2%
Split Mix Impact	0.3%	1.0%	2.6%	1.1%	0.2%	0.0%	0.0%	0.5%	0.3%	0.6%	1.4%	0.0%
Splits Revenues, Y/Y	10.6%	12.3%	1.9%	8.8%	6.7%	7.0%	1.8%	11.6%	-2.4%	8.7%	-8.1%	2.2%
Splits Revenue Contribution	7.2%	8.2%	1.3%	5.9%	4.5%	4.7%	1.2%	7.9%	-1.6%	6.0%	-5.6%	1.5%
Furnace Units, Y/Y	16%	5%	3%	5%	6%	9%	1%	-3%	3%	3%	3%	3%
Furnace Revenue Contribution	2.7%	1.0%	0.6%	0.8%	1.1%	1.4%	0.2%	-0.5%	0.4%	0.4%	0.4%	0.5%
Components Units, Y/Y	14%	11%	1%	8%	6%	7.0%	1.7%	11.2%	-2.9%	8.1%	-9.7%	2.2%
Components Revenue Contribution	2.3%	1.8%	0.2%	1.2%	1.1%	1.1%	0.3%	1.8%	-0.5%	1.3%	-1.6%	0.4%
Price (like-for-like)	0.2%	0.1%	0.5%	0.6%	0.6%	0.6%	1.0%	0.5%	0.5%	0.5%	0.5%	0.5%
Total Industry Revenues	12.4%	11.1%	2.5%	8.6%	7.3%	7.9%	2.7%	9.7%	-1.2%	8.3%	-6.3%	2.9%
Ex pre-buy impact		7.7%	7.9%	4.4%				7.6%	2.7%	3.3%	-0.8%	-0.2%

Source: AHRI data, J.P. Morgan estimates.

Our industry revenue estimates versus public company growth rates

The table below relates our industry revenue estimates back to the reported growth rates of major public HVAC players and the HARDI distributor survey. There is volatility year to year, but if we average the last seven years on an indexed growth basis, however, our industry model is about in line with the average of the major public players.

Table 58: J.P. Morgan Industry Revenue Estimate vs. Public HVAC Growth Rates

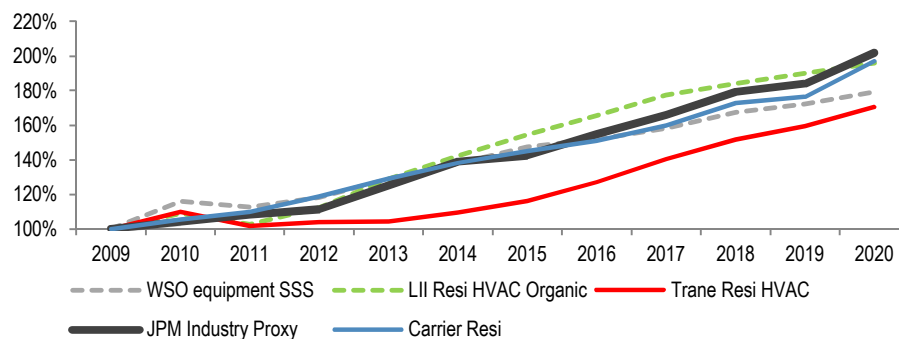
% Y/Y Change

	2013	2014	2015	2016	2017	2018	2019	2020	Avg
WSO equipment SSS	9%	7%	7%	3%	4%	6%	3%	4%	5%
LII Resi HVAC Organic	15%	10%	8%	7%	7%	4%	3%	3%	7%
Trane Resi HVAC	0%	5%	6%	9%	11%	8%	5%	7%	6%
Carrier Resi	9%	7%	5%	4%	6%	8%	2%	12%	7%
Goodman/Daikin US Resi Unitary	9%	8%	-5%	10%	4%	12%	3%	0%	5%
HARDI Survey	7%	7%	6%	9%	6%	13%	6%	~3.5%	7%
Avg of above	8%	7%	5%	7%	6%	8%	4%	5%	6%
JPM Industry Proxy	12%	11%	3%	9%	7%	8%	3%	9-10%	~8%

Source: Company reports, HARDI, J.P. Morgan estimates. * =2013 Daikin/Goodman data are on a unit only basis (excludes price/mix).

Figure 94: Indexed JPM Industry Revenue Growth Versus Public Players Resi Growth

2009 = 100%



Source: Company reports, J.P. Morgan estimates.

Long-Term View: Resi Unitary Market Normalizing

Having taken a view on the near-term market, this section takes a step back and provides an estimate of medium-term, “normalized” demand. Here, we believe the greatest challenge is identifying the sustainable, long-term run rate of add-on/replacement (AOR) demand. The key conclusions of our analysis are that:

- Housing will provide a continued near-term lift as household formation returns to levels more consistent with history, a process that began quite clearly in 2013 though the recovery trend is picking up on the back of COVID-19.
- Replacement demand is also likely to normalize at higher rates as consumers repair fewer units in a better economy. 2015-20 saw solid improvement on this front, continuing the solid pick-up of the two years prior. We saw replacement trending at above levels implied by macro indicators in 2020, then we expect some recoupling in '21.
- The penetration rates of central AC (and growth in the installed base) are slowing versus history as the product is now more mature. Historical industry growth rates included not just growth in the housing stock but also greater adoption in existing homes; something we think may have represented ~15% of shipments between 1970 and 2000. This tailwind should continue to gradually fade and become a headwind to growth rates in the out years.
- Therefore, after this cyclical rebound and above average normalized growth from “pent-up demand” and a housing “replacement boom” plays out, we expect unit demand to slow to rates more consistent with growth in the installed base and the overall housing stock. In our view, this likely means LSD revenue growth for the industry beyond the next several volatile years.

In the end, this brings us to a view of “normalized” unit demand, which we assume was ultimately exceeded in 2018 as replacement rates neared the upper end of historical ranges (~7%), moving even higher in 2020 despite COVID-19 related economic pressures.

Figure 95: Residential Unitary Shipments

Millions units, excludes light commercial (>65 BTUH units)



Source: AHRI data, J.P. Morgan estimates.

Market Model Basics

Resi HVAC unit sales

The basic principles behind our model are simple and intuitive. First, we note that all residential unit sales must represent either growth in the installed base or the replacement of an existing unit.

$$\text{Resi HVAC unit growth} = \text{growth in installed base} + \text{replacement}$$

Resi HVAC installed base

We can also break down the growth in the installed base into either (1) net growth in the housing stock; or (2) incremental penetration, or higher amounts of HVAC use in the same base of homes.

$$= \text{growth in housing stock} + \text{incremental penetration} + \text{replacement}$$

Review of Available Data

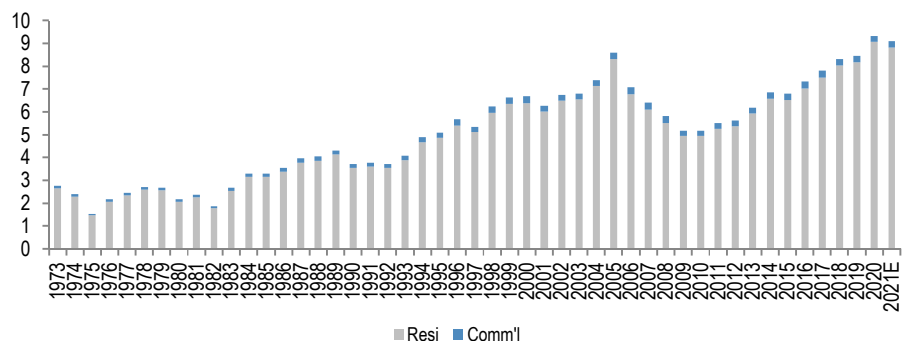
Although few would argue with this approach, the challenge is finding the data points to fit this to an empirical model. Below, we review some of the available data we use to inform our estimates.

AHRI shipment data

The most commonly followed, and most statistically accurate, set of HVAC data available is the AHRI monthly factory shipments of condensing units and heat pumps. This tracks all outdoor units shipped and is commonly used as a proxy for the industry. We use unitary shipments going back to 1973. Since 1997, AHRI also breaks out the size of the units. Keep in mind that “unitary” shipments also include sales for light commercial applications. As a rough rule, we assume anything over 65,000 BTUs is used for commercial while anything below this is residential. Before 1997, we assume that 4.5% of annual units are commercial units, in line with the historical average. This isolates an approximation of units sold into residential applications.

Figure 96: AHRI Annual Unitary Shipments (with JPM Estimates of Resi/Commercial)

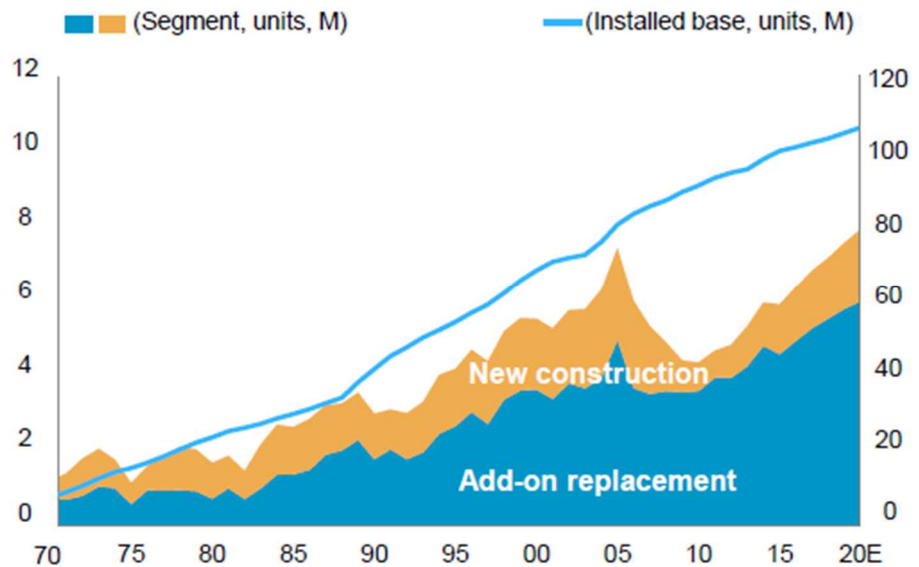
Millions of units



Source: AHRI, J.P. Morgan.

As a note, we also highlight charts from Carrier, which show their estimate of residential unit shipments from their market model, showing a similar trend.

Figure 97: Splits Systems Segment



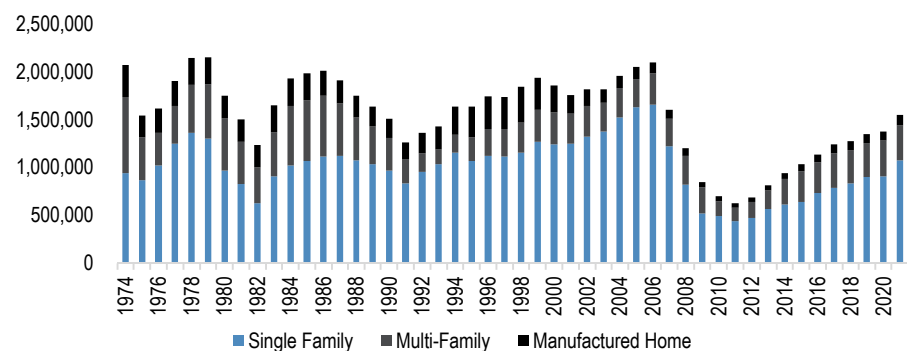
Source: Carrier.

Housing completions

The US Census remains the primary source for US housing data, including the most commonly followed housing starts. We use housing completions as the best proxy for HVAC sales given the equipment is installed near the end of the construction process. We also add on manufactured home placements, which are small today but represented a fairly significant part of housing growth in past decades.

Figure 98: Annual Housing Completions with 2021E

Units

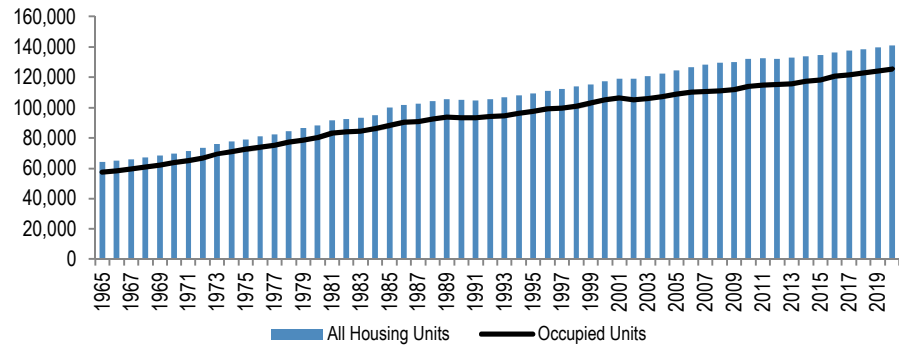


Source: US Census.

The US Census also reports its estimates of the total housing stock, both those that are occupied year-round and those partially (or fully) vacant. The increase in partially vacant homes in recent decades is due in part to the increase in part-time or second residences. The change in occupied units (also referred to as “household formation”) is a commonly used metric to track the growth in underlying demand for housing.

Figure 99: Growth in Housing Stock

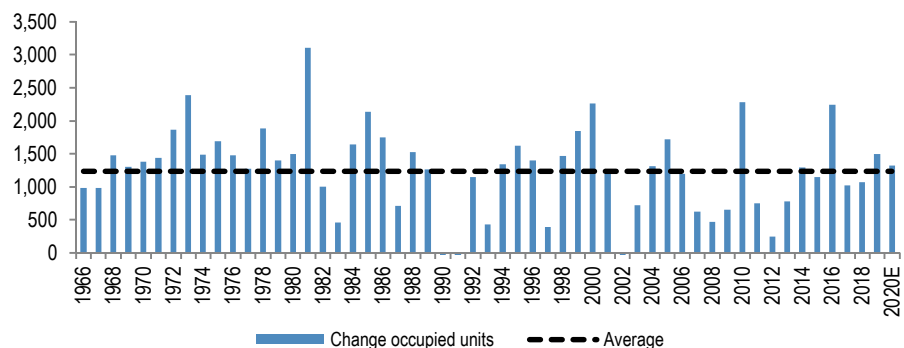
Thousands of units



Source: US Census.

Figure 100: Annual Household Formation

Thousands of units



Source: US Census.

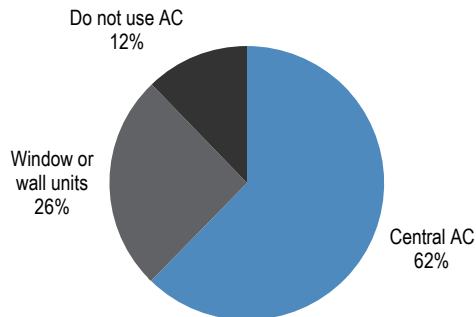
HVAC penetration data

There are two major sources of estimates for HVAC penetration data: the American Housing Survey (link [here](#)) and the Residential Energy Consumption Survey (link [here](#)). Both show directionally similar pictures of the A/C installed base, but there are slight differences in their survey methodology and the resulting data. We use the AHS data in our model given it is reported more frequently than RECS.

To understand HVAC penetration better, we look at various government-conducted household surveys on the housing stock. The two most relevant, in our view, are (1) the American Housing Survey (AHS) conducted every two years by the US Census Bureau, measuring a range of physical and demographic characteristics of existing homes, and (2) the Residential Energy Consumption Survey (RECS), which is typically done every four years by the EIA, which estimates the usage of anything energy-related, ranging from heating/cooling equipment to TVs, appliances, and computers. The charts below show examples of some of the data from the EIA. For example, the EIA estimates that just over 60% of homes in the US use central air, with ~25% using window/wall units only and the remaining homes with no air conditioning use.

Figure 101: HVAC Usage (2015) – All US Residential Households

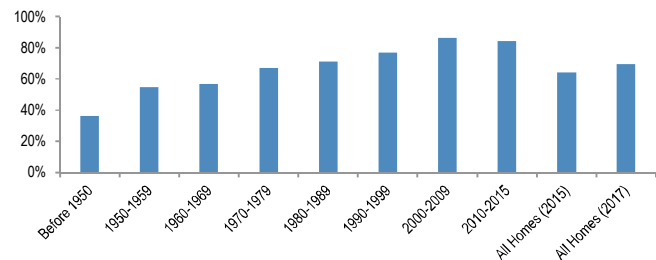
Existing occupied homes



Source: EIA.

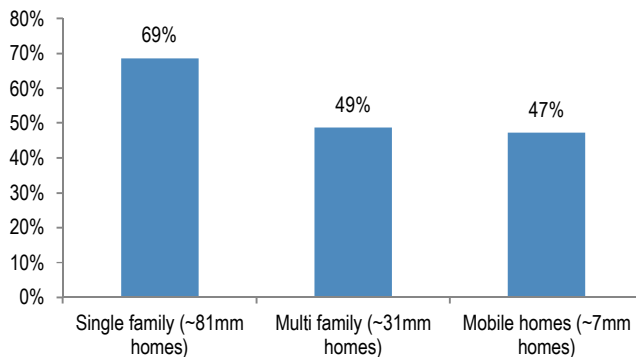
Figure 102: Central Air Penetration by Original Construction Date (2017)

Existing occupied homes



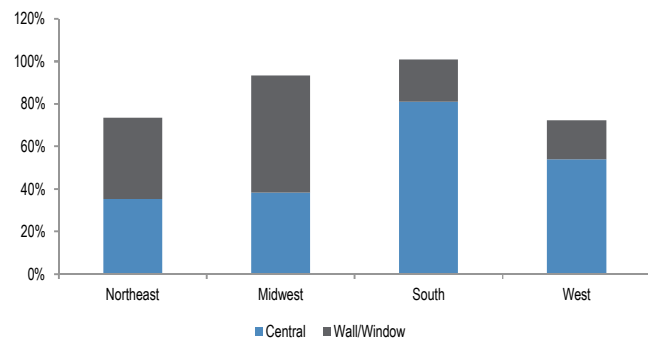
Source: EIA.

Figure 103: Central Air Penetration by Housing Type (2015)



Source: EIA.

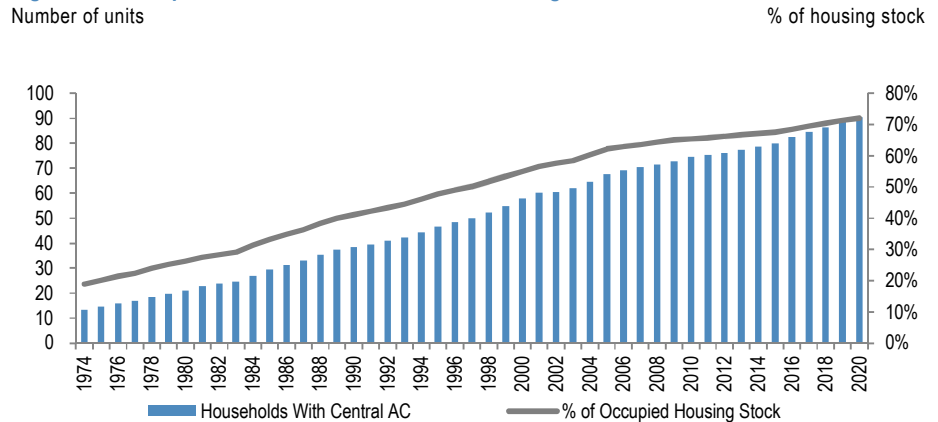
Figure 104: Air Conditioning Penetration by Region/Type (2015)



Source: EIA.

More interesting to us is the progression of central AC penetration over time. The chart below shows the estimate of homes along with the percentage of the overall housing stock (using the census data). This shows that central air penetration has moved from ~18% of occupied homes in 1973 to ~70% based on US Census data. We've historically focused on AC in occupied homes rather than the total stock of units given (1) more consistent availability of historical data, and (2) AC systems in vacant or occasional use homes are not as likely to see consistent use and, therefore, are less likely to require replacement. However, this year we are now using Carrier's historical data as a check on our model, and we believe this may include all installed AC units, not just those in occupied homes.

Figure 105: Occupied Homes with Central Air Conditioning



Source: EIA, J.P. Morgan estimates.

Fitting This to a Market Model

Here, we take the available data to form a market model for residential condensing units. This requires a number of assumptions to bridge the available data sources, which we describe below.

New construction units

Units related to new construction are not disclosed directly by AHRI but are relatively straightforward to estimate. We use the US Census data on single-family and multi-family penetration for housing completions going back historically, while we assume that penetration in new manufactured homes averages ~25% below the single-family rate (the current difference in central air penetration, according to the EIA). For single-family homes, we assume an average of 1.0 units per home in the 1970s and 1980s, increasing gradually to 1.15 units per home today to account for the larger average home size starting in the 1990s—our conversations with the forecast managers at large HVAC suppliers suggest this unit-per-house estimate is close to the industry consensus. Eyeballing Carrier’s estimate of “new construction” related units versus housing completions shows they are relatively tight at ~1.2-1.25 units/new housing completions for 2020 while our model shows ~1.15.

Table 59: Build of Annual Shipments for New Housing

= e + g + h			e = b * c * d							
			A	b	C	d	e	f	g	h
	New Construction Units	Y/Y Growth	Total Housing Completions	Single-Family Housing Completions	% with A/C (New)	Units per New Home	Single-Family Units	Multi-Family Housing Completions	Multi-Family Units	Manufactured Home Units
1973			2,105,250	1,197,000				908,250		
1974	1,216,432		1,738,167	945,500	48%	1.01	458,378	792,667	681,693	76,360
1975	832,120	-32%	1,317,500	871,583	46%	1.01	404,938	445,917	379,029	48,153
1976	824,169	-1%	1,368,167	1,026,500	49%	1.01	508,015	341,667	256,250	59,904
1977	1,074,480	30%	1,647,833	1,250,833	54%	1.01	682,205	397,000	317,600	74,675
1978	1,285,357	20%	1,863,500	1,367,167	58%	1.01	800,886	496,333	392,103	92,367
1979	1,360,763	6%	1,872,917	1,302,333	60%	1.01	789,214	570,583	473,584	97,965
1980	1,165,444	-14%	1,516,917	969,917	63%	1.01	617,158	547,000	459,480	88,806
1981	1,019,361	-13%	1,274,667	828,167	65%	1.01	543,691	446,500	383,990	91,680
1982	841,012	-17%	1,003,667	630,083	66%	1.01	420,014	373,583	325,018	95,981
1983	1,182,468	41%	1,375,167	910,250	70%	1.01	643,547	464,917	413,776	125,145
1984	1,422,152	20%	1,648,167	1,024,583	71%	1.01	734,729	623,583	554,989	132,434
1985	1,441,653	1%	1,704,083	1,072,083	70%	1.01	757,963	632,000	556,160	127,530
1986	1,452,274	1%	1,754,500	1,116,167	69%	1.01	777,857	638,333	561,733	112,684
1987	1,389,101	-4%	1,674,417	1,126,167	71%	1.01	807,574	548,250	471,495	110,032
1988	1,312,608	-6%	1,525,500	1,079,500	75%	1.02	825,818	446,000	374,640	112,150
1989	1,249,055	-5%	1,433,500	1,036,000	77%	1.02	813,674	397,500	329,925	105,456
1990	1,141,025	-9%	1,314,000	970,667	76%	1.03	759,838	343,333	281,533	99,654
1991	940,276	-18%	1,092,000	837,167	75%	1.03	646,711	254,833	206,415	87,150
1992	1,040,210	11%	1,151,833	958,417	77%	1.04	767,500	193,417	162,470	110,240
1993	1,096,012	5%	1,191,000	1,037,833	78%	1.04	841,890	153,167	125,597	128,525
1994	1,271,094	16%	1,345,833	1,160,833	79%	1.04	953,741	185,000	160,267	157,086
1995	1,279,769	1%	1,319,250	1,072,750	80%	1.04	892,528	246,500	211,571	175,670
1996	1,394,982	9%	1,405,583	1,122,583	81%	1.05	954,757	283,000	251,113	189,112
1997	1,409,244	1%	1,404,250	1,119,667	82%	1.05	964,033	284,583	253,520	191,691
1998	1,513,015	7%	1,473,167	1,157,750	83%	1.05	1,008,979	315,417	287,290	216,746
1999	1,629,885	8%	1,602,750	1,269,500	84%	1.06	1,130,363	333,250	299,925	199,597
2000	1,590,736	-2%	1,578,833	1,246,167	85%	1.06	1,122,796	332,667	299,400	168,540
2001	1,549,132	-3%	1,565,167	1,250,417	86%	1.06	1,139,880	314,750	289,570	119,682
2002	1,636,596	6%	1,645,750	1,324,750	87%	1.07	1,233,210	321,000	295,320	108,066
2003	1,657,567	1%	1,676,750	1,381,333	88%	1.07	1,300,663	295,417	268,829	88,074
2004	1,851,192	12%	1,834,583	1,527,833	90%	1.08	1,485,054	306,750	285,278	80,860
2005	1,923,917	4%	1,929,333	1,634,000	89%	1.08	1,570,601	295,333	274,660	78,656
2006	1,981,792	3%	1,989,000	1,661,667	89%	1.09	1,611,983	327,333	297,873	71,936
2007	1,526,396	-23%	1,513,833	1,228,000	90%	1.09	1,204,668	285,833	260,108	61,620
2008	1,133,944	-26%	1,126,833	826,167	89%	1.10	808,817	300,667	273,607	51,520
2009	799,452	-29%	795,500	521,750	88%	1.10	505,054	273,750	260,063	34,335
2010	658,754	-18%	653,750	495,417	88%	1.10	479,563	158,333	147,250	31,941
2011	595,543	-10%	584,583	446,333	88%	1.11	435,978	138,250	129,955	29,610
2012	658,416	11%	641,417	478,250	89%	1.11	472,463	163,167	153,377	32,576
2013	794,457	21%	763,167	569,500	91%	1.11	575,252	193,667	182,047	37,158
2014	931,732	17%	882,667	619,417	91%	1.12	631,309	263,250	257,985	42,438
2015	1,017,800	9%	965,250	646,750	93%	1.12	673,655	318,500	296,205	47,940
2016	1,135,732	12%	1,059,250	736,333	93%	1.13	773,813	322,917	306,771	55,148
2017	1,236,737	9%	1,151,000	794,000	93%	1.13	834,415	357,000	339,150	63,172
2018	1,287,380	4%	1,184,900	840,200	93%	1.14	890,780	344,700	330,912	65,688
2019	1,360,410	6%	1,255,100	903,200	94%	1.14	967,869	351,900	327,267	65,274
2020	1,406,583	3%	1,286,400	911,200	94%	1.15	985,007	375,200	356,440	65,136

Source: J.P. Morgan estimates.

Installed base

We triangulate our installed base estimates off a combination of Carrier data and the US Census data of households using central A/C. We assume slightly over 1.0 units per home, an approximation based on our assumed units per home above (increasing over time). Again, we have historically focused on occupied homes where the A/C system would see regular use, but we believe the Carrier data includes the entire stock of AC units, not just those in occupied homes.

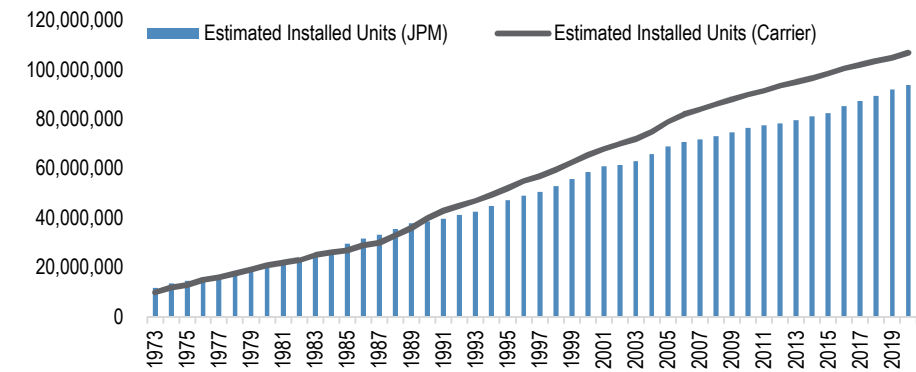
Table 60: Installed Base Estimates

units

	A	b	c = a * b	
	Occupied Homes w/ Central AC	Units per Home	Estimated Installed Unit Base	Carrier Estimated Installed Unit Base
1973	11,802,939	1.00	11,802,939	10
1974	13,392,178	1.00	13,442,642	12
1975	14,536,647	1.00	14,599,406	13
1976	15,872,745	1.00	15,951,043	15
1977	16,810,293	1.01	16,899,167	16
1978	18,491,000	1.01	18,592,251	18
1979	19,813,000	1.01	19,922,560	19
1980	20,988,000	1.01	21,103,355	21
1981	22,848,000	1.01	22,973,114	22
1982	23,834,386	1.01	23,963,625	23
1983	24,679,000	1.01	24,812,869	25
1984	26,947,155	1.01	27,092,695	26
1985	29,447,000	1.01	29,605,690	27
1986	31,389,993	1.01	31,559,074	29
1987	33,006,000	1.01	33,184,793	30
1988	35,302,545	1.01	35,508,723	33
1989	37,554,000	1.01	37,788,064	36
1990	38,444,864	1.01	38,711,099	40
1991	39,330,000	1.01	39,627,686	43
1992	40,905,004	1.01	41,252,600	45
1993	42,183,000	1.01	42,578,644	47
1994	44,292,729	1.01	44,743,769	50
1995	46,577,000	1.01	47,084,026	52
1996	48,474,167	1.01	49,045,529	55
1997	49,896,000	1.01	50,525,776	57
1998	52,264,553	1.01	52,963,972	60
1999	54,878,000	1.01	55,665,402	63
2000	57,763,424	1.02	58,645,037	66
2001	60,118,000	1.02	61,088,775	68
2002	60,469,780	1.02	61,510,685	70
2003	61,880,000	1.02	63,009,382	72
2004	64,633,061	1.02	65,890,654	75
2005	67,689,000	1.02	69,084,693	79
2006	69,217,315	1.02	70,734,501	82
2007	70,397,000	1.02	72,025,574	84
2008	71,539,693	1.02	73,285,123	86
2009	72,808,000	1.03	74,665,273	88
2010	74,630,251	1.03	76,620,237	90
2011	75,456,000	1.03	77,564,431	92
2012	76,205,739	1.03	78,426,786	94
2013	77,315,000	1.03	79,657,700	95
2014	78,654,371	1.03	81,132,896	97
2015	79,907,000	1.03	82,515,792	99
2016	82,594,039	1.03	85,394,642	101
2017	84,481,000	1.04	87,446,683	102
2018	86,393,142	1.04	89,539,341	104
2019	88,632,000	1.04	91,973,373	105
2020	90,410,104	1.04	93,931,523	107

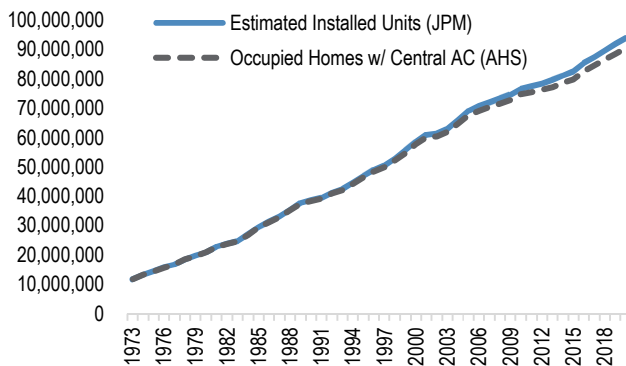
Source: US Census, J.P. Morgan estimates.

Figure 106: JPM vs Carrier Installed Base Estimates



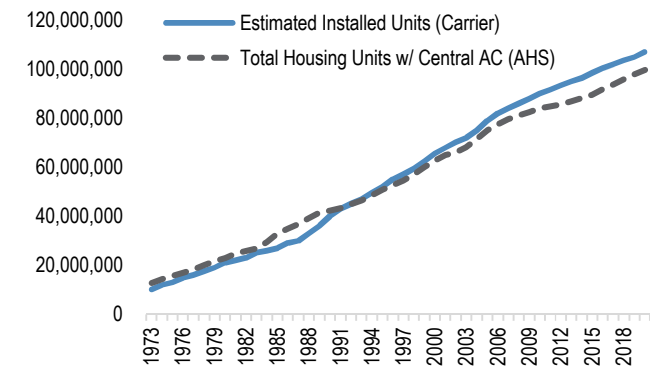
Source: Company reports, and J.P. Morgan estimates

Figure 107: JPM Installed Base Tracks Occupied Homes w/ AC



Source: J.P. Morgan, and US Census

Figure 108: Carrier Installed Base Tracks Total Homes w/ AC



Source: J.P. Morgan, Carrier, and US Census

Non-construction related penetration (add-on + adoption) remains the toughest to quantify . . .

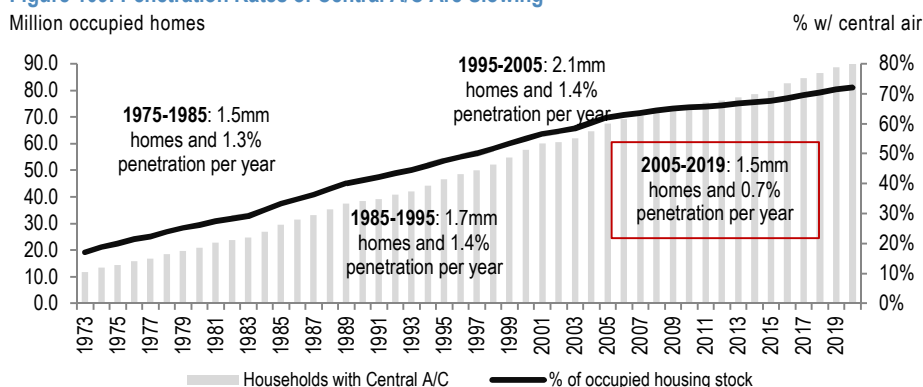
We next need to approximate the impact of increasing penetration over time, specifically increases in penetration not directly related to new housing. This would include (a) “adoption,” or the installation of A/C in an existing home that did not previously have central air, or (b) “add-on” units, an additional condensing unit installed in an existing home with a system in place. An example of an add-on would be the addition of a new bedroom, additional living area, or guest house that requires more AC. This is admittedly the most difficult to quantify, but a look at the growth in the installed base suggests there has been a material amount of penetration that is not explained by new housing alone.

. . . but directionally, slowing penetration looks clear

We think there is a clear trend where the degree of penetration is slowing as the industry matures. Indeed, it was much more common in the 1970s and 1980s for homes with heating ducts but no central air conditioning to install a cooling system. This reflected a product that was once a luxury becoming increasingly affordable for widespread use. Similarly, the construction boom of the 1990s, combined with a shift in population toward the Sun Belt and further adoption in existing homes, drove a big lift in penetration rates. More recently, however, the pace of adoption has clearly

slowed as the product has matured and growth in the installed base is now more in line with the underlying housing stock.

Figure 109: Penetration Rates of Central A/C Are Slowing



Source: US Census, J.P. Morgan.

We estimate non-construction adoption/add-on at ~500K-1mm units

There is admittedly no precise way to quantify the impact of adoption/add-on activity historically, but we can get to a good approximation from available data. The calculation we use is as follows:

Table 61: Illustration – JPM Approximation of Non-Construction Penetration

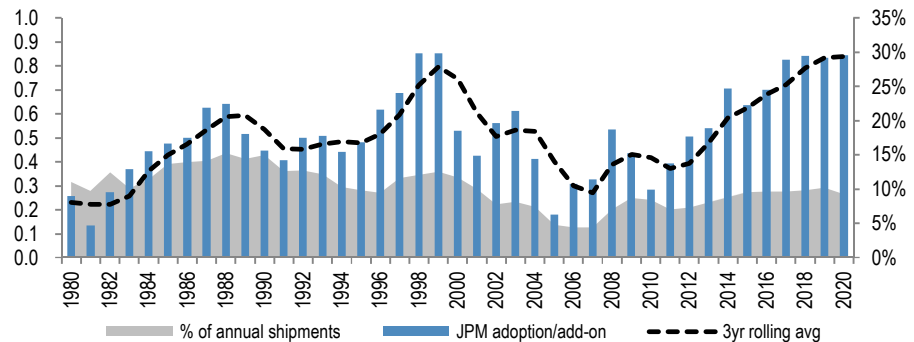
	Change in unit installed base of occupied homes	As estimated by US Census data
Less	Increase in installed base due to new housing	JPM estimates – see above
	Change in installed base due to adoption/add-on	

Source: J.P. Morgan estimates.

There is lumpiness in the data, reflecting variability in the US census surveys, which we smooth out over time by using a rolling average. The result, however, is an estimate of annual penetration that we show in the chart below. We believe that non-construction adoption has averaged ~500 thousand units since the 1980s, with a peak around 15-20% of industry shipments during the 1980s, which compares to roughly ~10% of industry shipments currently. We acknowledge that the magnitude of this effect is an estimate, but directionally the trends should hold. In other words, the impact to unit growth from add-on replacement demand has diminished over time as penetration has increased.

Figure 110: Non-Construction Adoption/Penetration Is Now Less Important to Unit Growth

Millions of units from non-construction adoption add-on % of annual shipments

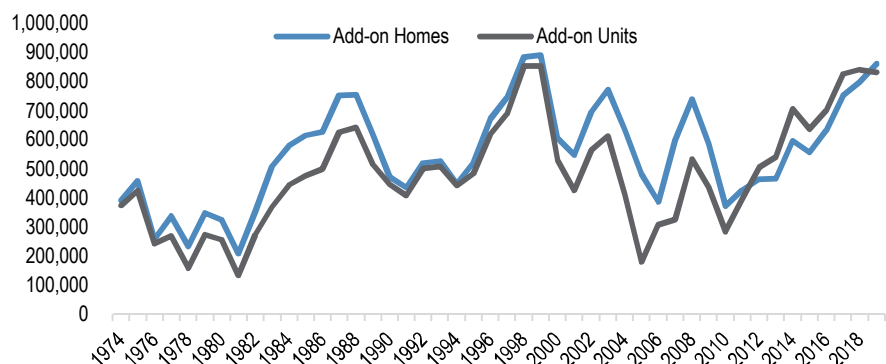


Source: J.P. Morgan estimates.

As a sanity check on our assumptions, we take a similar approach to "add-on homes," which we define as the change in homes with central AC each year (we get the American Housing Survey data every two years, and take an average of those every other year), less the amount implied by housing completions with central AC. When both are smoothed out with a rolling average, we can see they move together showing the correlation reflected in our model. We recognize the imperfection of this approach, relying on AHS surveys, but this is the best approach we can take in the absence of verified installed base statistics as discussed earlier.

Figure 111: Comparison of Add-on Homes and Add-on Units Shows Similar Trends in Our Model

Total add-on homes/AC units



Source: J.P. Morgan estimates

Replacement demand falls out of our other assumptions

The last remaining category is "replacement demand," in this case representing the direct replacement of units already in place that have reached the end of their useful life. Our estimate of replacement demand falls out of our prior estimates, representing the difference between total shipments and our estimates of units associated with new housing and non-construction add-on/adoption. We show non-construction adoption/penetration broken out from replacement below, but given difficulty in estimating them separately and no verified installed base statistics, we focus in our forecast on the combined add-on/replacement (AOR) units vs. new housing units.

Table 62: Replacement Demand Estimates

Units					
	a	b	c	d = a - b - c	
	Residential Unitary Shipments	New Construction Units	Non-Housing Penetration & Add-on (JPM Est)	Replacement Shipments	Y/Y Growth
1973	2,643,241				
1974	2,281,900	1,216,432	373,958	691,510	
1975	1,472,117	832,120	425,128	214,870	
1976	2,062,046	824,169	241,919	995,958	
1977	2,353,540	1,074,480	269,613	1,009,447	
1978	2,592,478	1,285,357	158,747	1,148,374	14%
1979	2,559,970	1,360,763	274,022	925,185	-19%
1980	2,069,212	1,165,444	256,233	647,535	-30%
1981	2,260,946	1,019,361	133,277	1,108,307	71%
1982	1,777,487	841,012	273,853	662,622	-40%
1983	2,548,247	1,182,468	368,655	997,124	50%
1984	3,159,549	1,422,152	444,593	1,292,804	30%
1985	3,142,437	1,441,653	476,202	1,224,582	-5%
1986	3,395,627	1,452,274	499,192	1,444,161	18%
1987	3,777,086	1,389,101	625,018	1,762,967	22%
1988	3,866,997	1,312,608	641,480	1,912,910	9%
1989	4,129,837	1,249,055	515,571	2,365,211	24%
1990	3,560,909	1,141,025	446,052	1,973,832	-17%
1991	3,600,697	940,276	407,326	2,253,094	14%
1992	3,546,297	1,040,210	501,242	2,004,845	-11%
1993	3,887,143	1,096,012	508,266	2,282,865	14%
1994	4,675,577	1,271,094	442,014	2,962,469	30%
1995	4,859,098	1,279,769	483,299	3,096,031	5%
1996	5,415,485	1,394,982	618,851	3,401,652	10%
1997	5,117,505	1,409,244	688,400	3,019,861	-11%
1998	5,959,838	1,513,015	853,953	3,592,870	19%
1999	6,350,084	1,629,885	854,035	3,866,164	8%
2000	6,378,836	1,590,736	529,010	4,259,090	10%
2001	6,004,751	1,549,132	425,383	4,030,236	-5%
2002	6,488,396	1,636,596	562,394	4,289,406	6%
2003	6,549,179	1,657,567	611,671	4,279,941	0%
2004	7,132,026	1,851,192	411,167	4,869,668	14%
2005	8,324,816	1,923,917	179,135	6,221,764	28%
2006	6,766,864	1,981,792	307,606	4,477,466	-28%
2007	6,088,311	1,526,396	325,761	4,236,153	-5%
2008	5,526,657	1,133,944	533,630	3,859,083	-9%
2009	4,945,777	799,452	436,283	3,710,043	-4%
2010	4,959,289	658,754	283,971	4,016,564	8%
2011	5,272,801	595,543	393,748	4,283,509	7%
2012	5,367,837	658,416	505,003	4,204,418	-2%
2013	5,921,853	794,457	539,216	4,588,180	9%
2014	6,586,446	931,732	705,276	4,664,437	2%
2015	6,538,233	1,017,800	636,576	5,168,858	11%
2016	7,036,796	1,135,732	701,808	5,199,256	1%
2017	7,495,325	1,236,737	826,049	5,432,540	4%
2018	8,020,377	1,287,380	842,493	5,890,504	8%
2019	8,161,142	1,360,410	834,439	5,966,293	1%
2020	9,066,842	1,406,583	844,976	6,815,283	14%

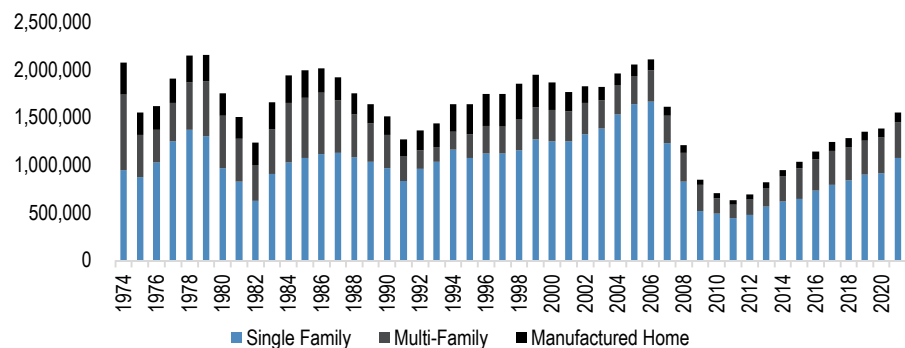
Source: AHRI, J.P. Morgan estimates.

Forecasting New Construction

There is much written on the US housing market, and it is not the focus of this report. As background, our JPM Econ team currently forecasts 2021 housing starts of ~1.63mm, representing ~18% y/y growth. Looking at past cycles would indicate a “normalized” housing level of ~1.4-1.5mm units, just above the ~1.38mm in 2020, with 2021 moving above that normalized rate.

Figure 112: Annual Housing Completions

Units



Source: US Census.

Housing demand is currently supported by favorable interest rates, highlighted by a 30-year mortgage rate down ~75-100bps in the past year, now around 3%, with the 10- and 30-year treasury rates at 1.4%/2.2%, and expected to only move up to ~1.65%/~2.40% over the next year according to the JPM Economics research team. Affordability metrics remain favorable, and according to analysis from JPM’s Homebuilders & Building Products team, even with a 100bps increase in rates the index would remain 3-5% above long-term averages.

Figure 113: Affordability Scenario Analysis Using Different Mortgage Rates

		Affordability Composite Index				
		Monthly Payment		% of income		
	30-Yr. Fixed Mortgage	Index	20% Down	10% Down	20% Down	10% Down
Current	2.7%	170.9	\$1,032	\$1,161	14.6%	16.5%
Current +100 bps	3.7%	150.6	\$1,171	\$1,318	16.6%	18.7%
Current +200 bps	4.7%	133.7	\$1,320	\$1,485	18.7%	21.0%
30-Year Average	6.0%	143			18.0%	20.3%
		First-Time Buyer Affordability Index				
		Monthly Payment		% of income		
	30-Yr. Fixed Mortgage (incl. PMI)	Index	20% Down	10% Down	20% Down	10% Down
Current	3.0%	109.7	\$894	\$1,006	20.3%	22.8%
Current +100 bps	4.0%	96.8	\$1,013	\$1,140	23.0%	25.8%
Current +200 bps	5.0%	86.1	\$1,139	\$1,282	25.8%	29.0%
30-Year Average	6.3%	94.4			24.2%	27.2%

Source: NAR, J.P. Morgan estimates. Note: Mortgage rate estimate based on published FHFA data plus the change in the mortgage rates from Bankrate.com. Data taken from JPM research report published on 12/16/20.

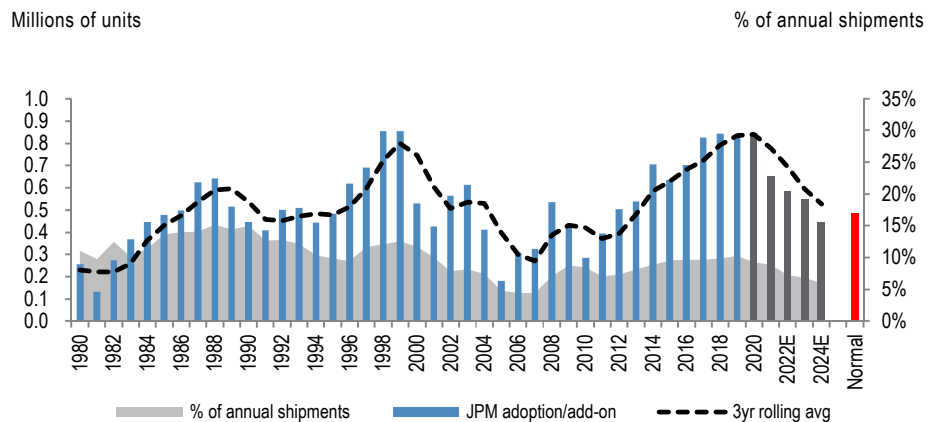
Forecasting Add-On/Replacement (AOR) Demand

Determining the appropriate level of add-on/replacement (AOR) demand is the most important long-term driver, and the most challenging to forecast. We come to a medium-term, normalized AOR demand of ~7 million units versus 7.7 million in 2020, or about ~10% lower.

Non-construction adoption / add-on units tough to quantify

This represents primarily units installed in existing homes that did not previously have a central AC system. This is difficult to quantify, but we believe it was a bigger driver relative to overall industry unit shipments in the 1980s and 1990s when air conditioning became more widely used and penetration rates increased rapidly (beyond what was implied by new home construction). Our model implies the absolute level normalizes toward the longer-term average, which would represent about 5% of annual shipments in the out years, down from 15-20% at the peak. Like replacement demand, there is clearly some cyclical element to these shipments as homeowners appear more willing to add a new system to their home in a better economy, which is why we combine the two when thinking about the forecast. We assume some of this cyclical lift offsets what should otherwise be declining incremental adoption (due to high penetration). In other words, this is somewhat of a non-factor versus today's run rate.

Figure 114: We Assume Non-Construction Adoption / Add-on Units Normalize Over the Medium Term



Source: J.P. Morgan estimates

Isolating “replacement demand” vs “add-on units” is challenging . . .

We think many historical presentations of “replacement” demand can be misleading in that they may include the impact of add-ons and adoption in existing homes. For this reason, we think the conventional approach of looking at all non-housing-related units may overstate the rate at which systems were being replaced historically.

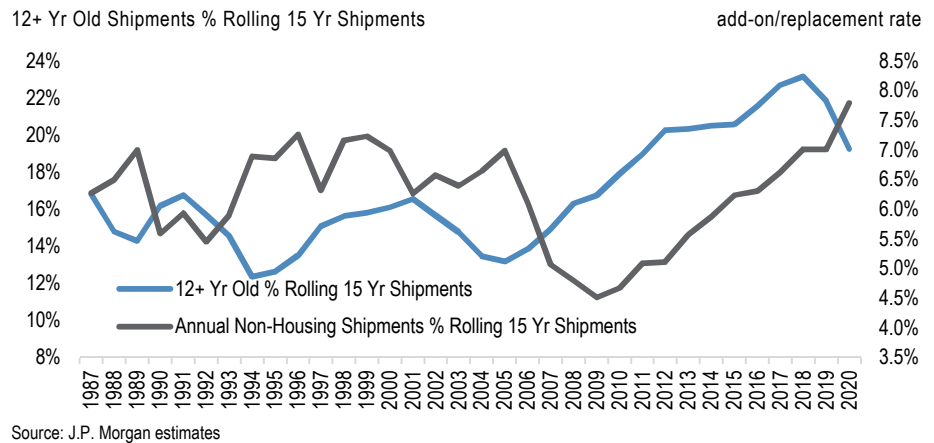
. . . as is estimating the relevant “replacement pool”

Similarly, despite access to fairly precise historical shipment data, it is exceedingly difficult to quantify the age of the installed base or the number of units reaching the end of their useful life. The most intuitive approach that we have used in the past is to take an assumed useful life of the unit (say, 10-15 years) and treat all historical shipments from 10-15 years ago as the “replacement pool.” There are a few problems with this approach, however, including:

- *Demolished or vacant units*—Just because a unit was shipped doesn't mean it is still in use today. The home using that system may have been demolished or vacated, and there is no practical way to identify the age of units taken out of service. We also estimate as many as 5 million units historically shipped to mobile/manufactured homes, many of which may no longer be in use.
- *Mixing effect*—There is a fairly wide range of estimates of a system's useful life, with systems in warm climates often breaking after 10-12 years but cooler climate systems lasting as much as 20+ years. There is also unit-specific variance, with some units getting replaced early due to unusual circumstances and others lasting much longer than normal. Frost & Sullivan estimated that ~80% of replacements are made for "end of life reasons."
- *Differences in utilization*—In recent years an increasing number of systems have been sold into seasonal homes, for example, which are not necessarily running year-round. Similarly, a second condensing unit in the same home may not be required to operate at the same intensity of a single unit.
- *Limited historical correlation between installed base age and replacement rate* – On an intellectual level, it makes sense to assume that as the installed base ages, the replacement rate should go up due to more unit break opportunities. We agree with this logic, and it makes sense to us, but examining historical correlation between installed base age and replacement rate shows only a limited correlation. This makes some sense given replacement rates, including willingness for add-ons, can change quickly depending on fluctuations in the consumer economy, while the installed base age is more static. Indeed, 2007-2009 shows a clear divergence, with an uptick in replacement age units corresponding with a sharp downtick in replacement rate. On the whole, however, there does seem to be some correlation here in more normal economic environments.

By the time all these factors interact, we think the “replacement pool” gets blurred to the point that looking at small pockets of historical shipments is less useful as an indicator of replacement demand. Indeed, if we were to run this analysis using (for example) 14- to 16-year-old shipments as our replacement pool, the analysis would tend to be skewed by the denominator (or short-term changes to the installed base). In our view, this doesn't seem logical. This said, age of the installed base (12+ Yr Old Shipments as % of Rolling 15 Yr Shipments) does appear to be a good leading indicator for add-on/replacement rates. As a point of reference, the OEMs have chimed in somewhat on what they see as useful life with Carrier recently noting 18 years, and Trane management suggesting extended warranty has pushed the breaking age to the right.

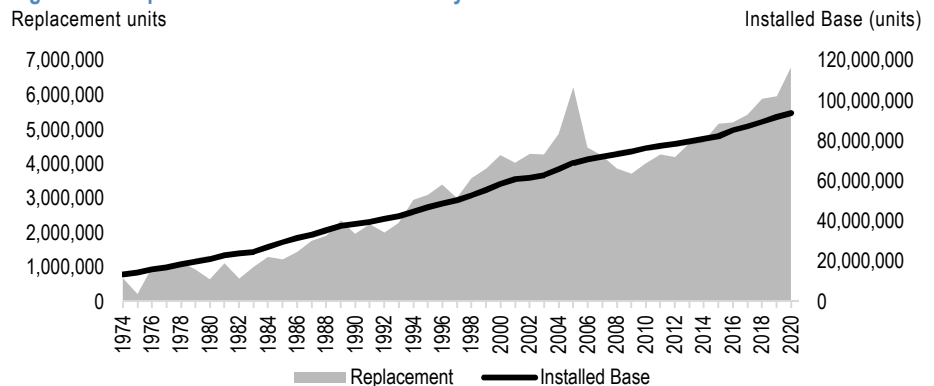
Figure 115: Installed Base Age vs Replacement Rate



Replacement demand relative to the installed base is the more stable historical relationship

For this reason, we think replacement is best measured as a percentage of the total installed base. As shown below, a long-term look at the market suggests they have generally grown at about the same rate on a multi-decade basis.

Figure 116: Replacement Demand Has Generally Grown In Line with the Installed Base



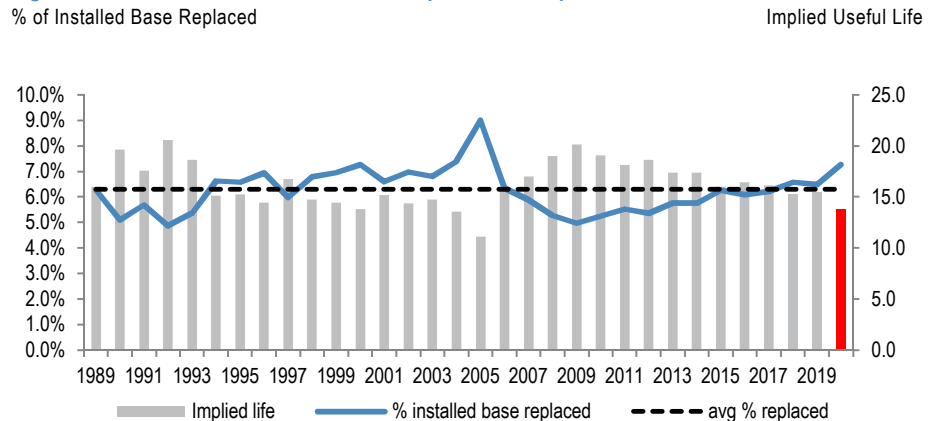
As a sanity check, we also take a simpler approach and relate replacement demand to the installed base and average equipment life. Assuming no growth in the installed base and a constant useful life, replacement demand in the long run should stabilize at a rate where:

$$\text{Replacement demand} = \text{installed base} / \text{useful life}$$

The chart below shows both annual replacement demand as a percentage of the installed base, and implied average equipment life. In this case, “equipment life” would be from installation to replacement inclusive of repairs (i.e., a unit shipped in 1990, repaired with a service compressor in 2005, and ultimately replaced in 2008 would have an 18-year life). Although the analysis is simplified, we have found the relationship has held fairly steadily over the last 30 years, and it implies an average all-in useful life of approximately 16 years. This makes sense to us as it’s roughly consistent with commentary across the industry. We see the implied life of units increasing with commentary from OEMs of increased demand for repairs over

replace even before COVID-19 onset. Specifically speaking with CARR, they see the useful life of equipment slightly increasing over time.

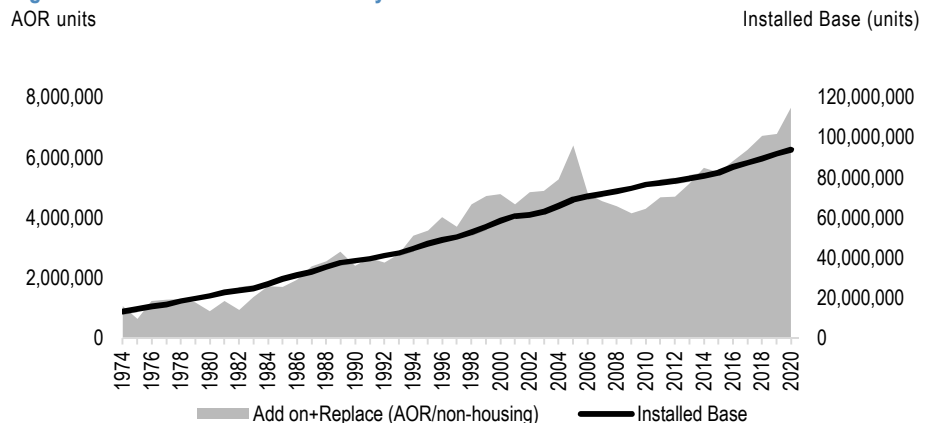
Figure 117: Historical % of Installed Base Replaced and Implied Life



Source: J.P. Morgan estimates.

Combining replacement with add-ons, we show the AOR as a percentage of the total installed base below. Like the replacement only analysis earlier, the long-term look at the market suggests they have generally moved higher with the installed base on a multi-decade basis.

Figure 118: AOR Demand Has Generally Grown In Line with the Installed Base

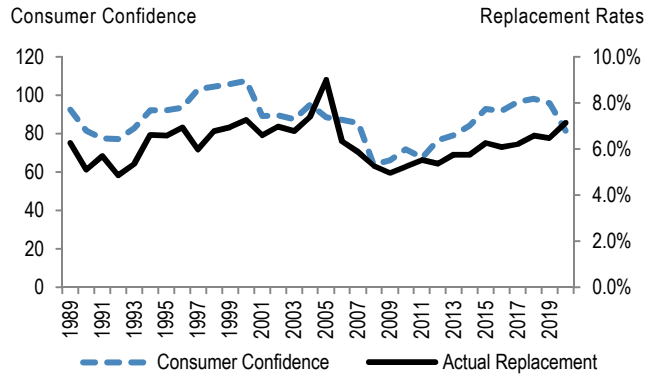


Source: J.P. Morgan estimates.

Replacement rates tend to cycle with housing/consumer data

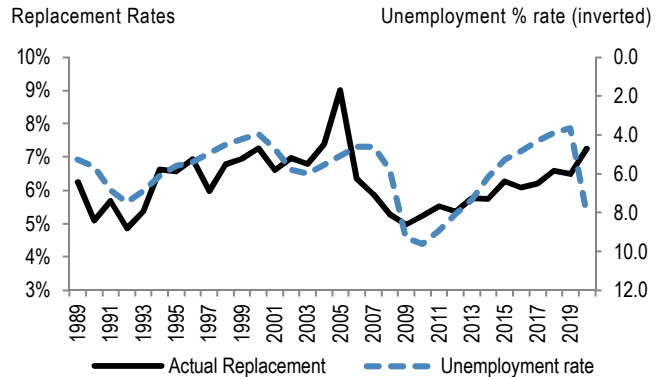
As expected, historical replacement rates (replacement units as % of installed base) tend to move with overall indicators of the consumer economy and housing fundamentals (including add-ons would show similar correlations over time). A broad look at macro indicators suggests that consumer confidence and unemployment rates are fairly good at explaining directional moves in replacement activity. Interestingly, however, replacement rates' correlation with housing data such as starts, home prices, or existing home sales is actually slightly higher. This confirms conventional wisdom that home values play a significant role in consumers' willingness to invest in their HVAC system.

Figure 119: Historical Replacement Rates Versus Consumer Confidence



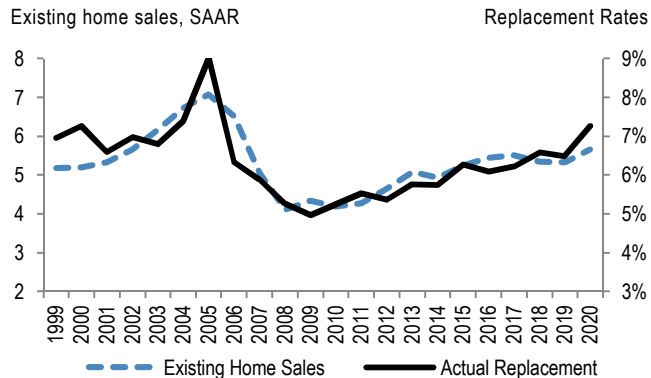
Source: J.P. Morgan estimates, Thomson Reuters-University of Michigan.

Figure 120: Historical Replacement Rates Versus Unemployment Rates



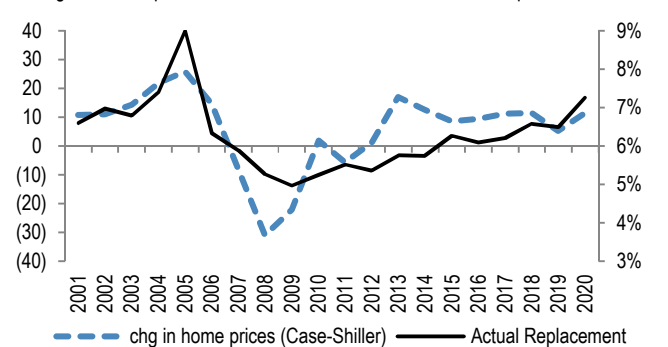
Source: BLS, J.P. Morgan estimates.

Figure 121: Historical Replacement Rates Versus Existing Home Sales



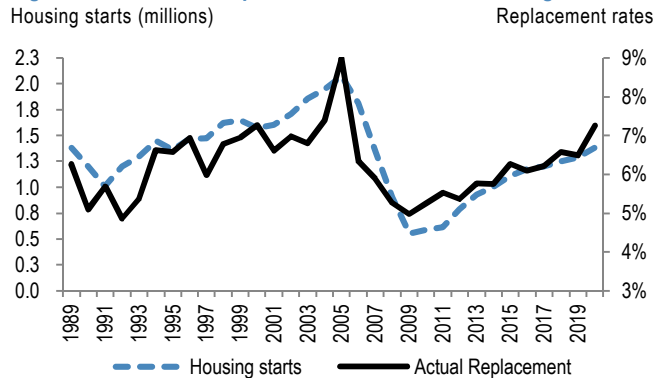
Source: NAR, J.P. Morgan estimates.

Figure 122: Historical Replacement Rates Versus Case-Shiller Index



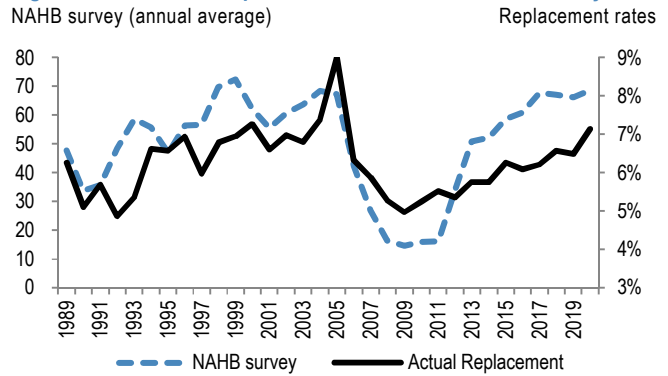
Source: S&P Case-Shiller, J.P. Morgan estimates.

Figure 123: Historical Replacement Rates Versus Housing Starts



Source: US Census, J.P. Morgan estimates.

Figure 124: Historical Replacement Rates Versus NAHB Survey



Source: NAHB, J.P. Morgan estimates.

Has equipment been built to last longer?

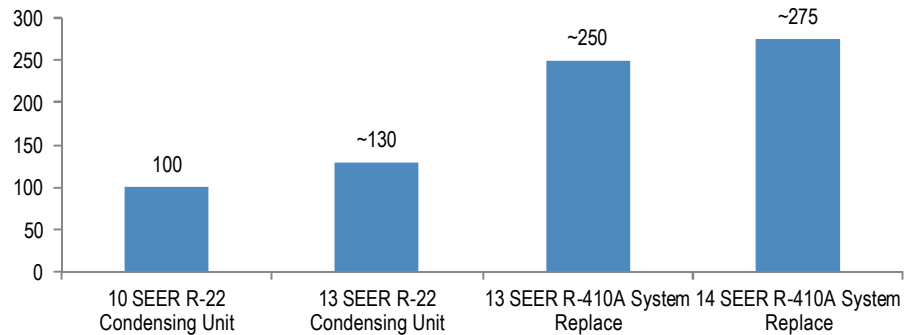
While this is an important dynamic to consider, we do not think the average useful life of AC condensing units has changed materially. Keep in mind that while some product engineering may have been improved, there are also several factors that have arguably made equipment more fragile. For example, commodity costs and higher efficiency requirements have moved many units from heavy-gauge metal to thinner structures that are sometimes more vulnerable to breaks. Similarly, higher SEER equipment has increased the electronics content within the condensing unit, which improves efficiency but creates more components at risk of malfunctioning.

Structurally higher costs remain a risk, but recent strength somewhat mitigates this concern

If there is one potential structural change in the industry in the last 15 years, it would likely be the upfront cost of a replacement. Note that in 2005, the industry standard was a 10 SEER R-22 product, which on an indexed value (ignoring inflation) cost 30% less than comparable R-22 replacement post the 13 SEER transition in 2006 and roughly 60-65% less than what a consumer would pay today for a minimum efficiency R410A system (given that a R410A system changeout requires replacement of the coil and other indoor components). A recovery in replacement rates over the past several years suggests consumers have been able to absorb this cost. Keep in mind, however, that with another step up in efficiency and a new refrigerant rule, cost will move up again.

Figure 125: Cost of A/C Replacement Has Increased over the Last Decade

Indexed cost (10 SEER R-22 = 100), ignoring inflation

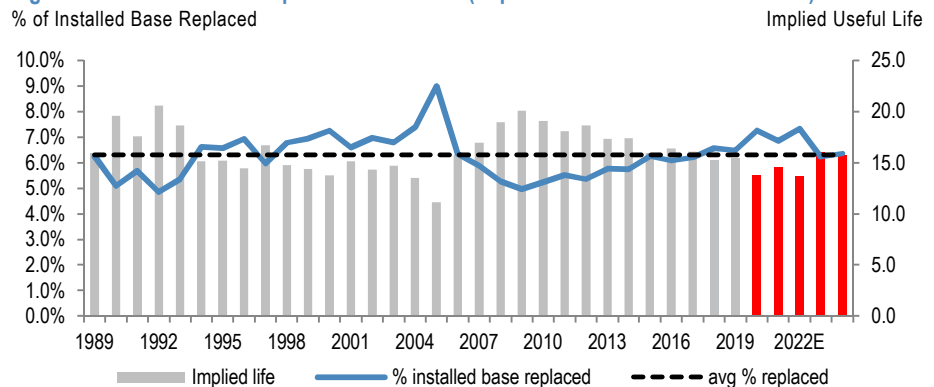


Source: J.P. Morgan estimates.

Our base case assumes replacement rates are more volatile

Taking all of this into account, we see volatility in replacement rates, after the unexpected step up in 2020, but we see a recouple to “normal” once we move beyond the coming period of regulatory change. Moving beyond this time period, we no longer see either pent-up demand or the influence of the housing boom, and, to the contrary, could see pressure from the housing downturn.

Figure 126: Medium-Term Replacement Demand (Replacement as % of Installed Base)

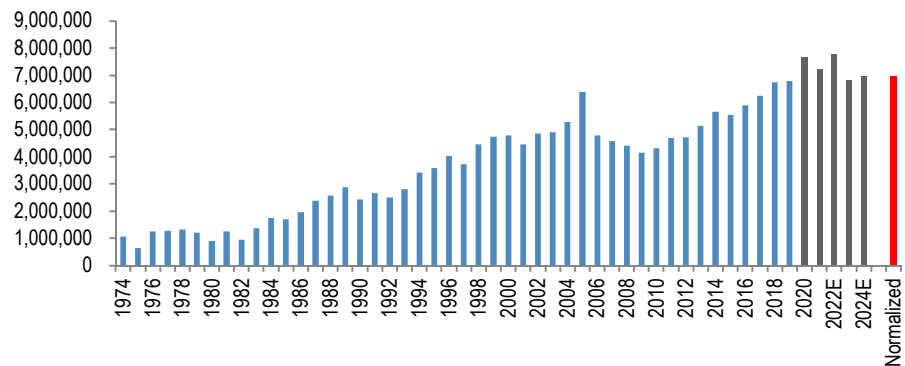


Source: J.P. Morgan estimates.

From an AOR perspective, we come to a medium-term, normalized demand level of ~6.6 million units versus the ~7.6 million we estimate in 2020, or about ~15% lower than current levels, though with a growing installed base this moves to ~7 million in our 2024 estimates.

Figure 127: AOR Demand Expected to Normalize at Lower Levels in Medium Term

units

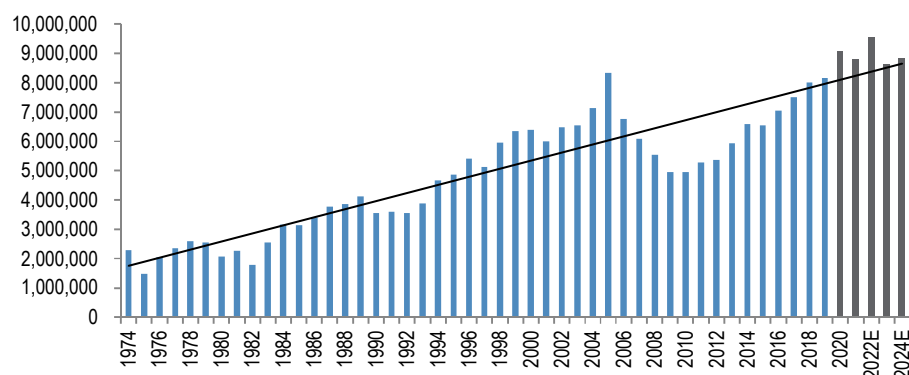


Source: J.P. Morgan estimates

Zooming out bigger picture, the overall residential HVAC market, including new housing units, regained its trendline in 2017/2018, meaning we are no longer early in the cycle. 2020 was a better than expected year against a weak macro backdrop, but underlying fundamentals + looming 2023 efficiency regulations suggest it will move further above trend into 2022, following which we would expect a down year for the industry. From 2020 through 2024 we see a slight decline driven by lower AOR demand as pent-up demand from the last downturn and the housing echo bubble effect subside, while this will be partly offset by growth in new housing units, a smaller subset of the market.

Figure 128: Overall Residential HVAC Market Regained Trendline in 2017/2018, Unexpectedly Held Above in 2020, Expected to Rise Further into 2022, Followed by a Re-trace in 2023/2024

units

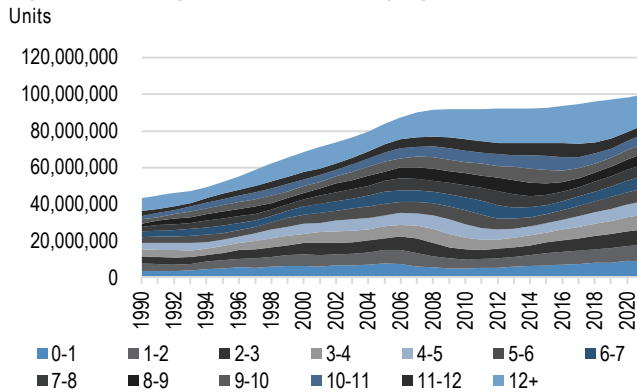


Source: AHRI and J.P. Morgan estimates.

Supporting this view, we show next the rolling 15-year shipment totals, which are approaching 100mm in 2020. Looking at the age cohorts, we saw a peak in the 12+ year old vintage in 2018. While we acknowledge that there are units in the installed base that are over 15 years of age, meaning it's not fully representative, the point is to look at evolution of the average age of rolling 15-year shipments as a leading indicator for annual shipments, as intuitively it would make sense that the older it gets, the higher the replacement activity should be. This seems to play out in the data,

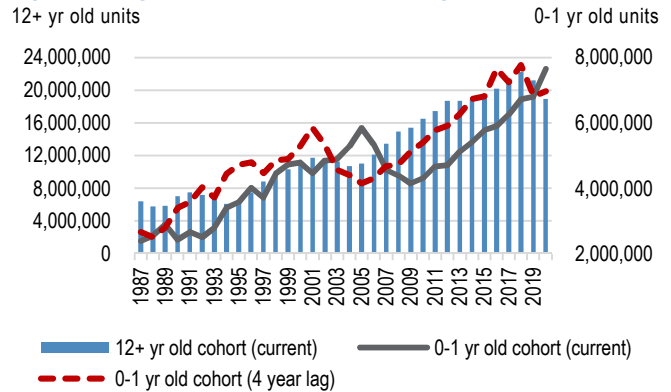
with the 12+ year old cohort peaking at 17% of the rolling 15-year shipment totals in 2001, followed by a peak in shipments four years later in 2005 which we normalize for 13 SEER pre-buy. With the 12+ year old cohort peaking at 23% of the rolling 15-year shipment totals in 2018, this would suggest to us a peak in industry shipments in 2022, coincidentally at the same time as the next regulatory change, following which we'd expect the industry to decline for perhaps 2-3 years.

Figure 129: Rolling 15 Year Shipments By Age Cohort



Source: AHRI, and J.P. Morgan estimates

Figure 130: Age of Installed Base Leads Changes in New Shipments



Source: AHRI, and J.P. Morgan estimates

Market “Normalized” In 2017, Smooth Sailing Through '19, Next Five Years Will Be Volatile Like '20 Was

2013 through 2019 were good years for add-on/replacement demand, with replacement rates (as a percentage of installed base) climbing, and reaching the high end of historical levels (~7-8%). Despite COVID-19 and weaker macro indicators, given '20 held in better than the macro would suggest we think it was better than it should have been, making for some headwinds in '21, as the industry recouples to the macro, assuming the economy does fully recover. We then see a move up on a modest pre-buy in '22, which then gets given back in '23, before normalizing to historical average replacement rate in '24. We believe that, on net, the next several years and those beyond them will trend more in line with the installed base growth, which has slowed as the industry has matured.

Table 63: Resi HVAC Market Summary

Units and %

Year	Total Shipments	y/y Growth	New Construction	y/y Growth	Add-on Replacement	y/y Growth	AOR Rate
2000	6,378,836	0%	1,590,736	-2%	4,788,100	1%	8.2%
2001	6,004,751	-6%	1,549,132	-3%	4,455,619	-7%	7.3%
2002	6,488,396	8%	1,636,596	6%	4,851,800	9%	7.9%
2003	6,549,179	1%	1,657,567	1%	4,891,612	1%	7.8%
2004	7,132,026	9%	1,851,192	12%	5,280,835	8%	8.0%
2005	8,324,816	17%	1,923,917	4%	6,400,899	21%	9.3%
2006	6,766,864	-19%	1,981,792	3%	4,785,072	-25%	6.8%
2007	6,088,311	-10%	1,526,396	-23%	4,561,915	-5%	6.3%
2008	5,526,657	-9%	1,133,944	-26%	4,392,713	-4%	6.0%
2009	4,945,777	-11%	799,452	-29%	4,146,325	-6%	5.6%
2010	4,959,289	0%	658,754	-18%	4,300,535	4%	5.6%
2011	5,272,801	6%	595,543	-10%	4,677,258	9%	6.0%
2012	5,367,837	2%	658,416	11%	4,709,421	1%	6.0%
2013	5,921,853	10%	794,457	21%	5,127,396	9%	6.4%
2014	6,586,446	11%	931,732	17%	5,654,714	10%	7.0%
2015	6,538,233	-1%	1,017,800	9%	5,520,433	-2%	6.7%
2016	7,036,796	8%	1,135,732	12%	5,901,064	7%	6.9%
2017	7,495,325	7%	1,236,737	9%	6,258,588	6%	7.2%
2018	8,020,377	7%	1,287,380	4%	6,732,997	8%	7.5%
2019	8,161,142	2%	1,360,410	6%	6,800,732	1%	7.4%
2020	9,066,842	11%	1,406,583	3%	7,660,259	13%	8.2%
2021E	8,822,409	-3%	1,588,048	13%	7,234,361	-6%	7.5%
2022E	9,542,167	8%	1,757,649	11%	7,784,518	8%	7.9%
2023E	8,637,954	-9%	1,825,722	4%	6,812,232	-12%	6.8%
2024E	8,831,552	2%	1,859,937	2%	6,971,615	2%	6.8%

Source: J.P. Morgan estimates and AHRI

Post normalization risk: 2007 housing downturn and sluggish recovery could create a soft pocket for replacement opportunities beyond 2020

Our base case view on the market in recent years has been that the early 2000s housing bubble and release of pent-up demand from the recession should sustain above average MSD type growth out through 2020, after which the market should logically revert back to a normalized run-rate and grow in line with the installed base (+LSD). Looking beyond this, we now assume that replacement+add-on demand (non-housing) will be flattish from 2019 through 2024; however, as outlined in our downside case earlier, we do think there could be risk to this assumption as the opposite dynamic of the “replacement bubble” starts to layer in, meaning less units will potentially be coming up for replacement given the housing market crash in 2007 and subsequent sluggish recovery. Mirroring our upside case from above, where we noted that 2002-06 saw 1.8mm housing completions per year on average versus historical averages of 1.4mm, 2007-20 has seen ~1mm completions per year on average. Setting this against our base case market unit growth out to 2024, this differential could represent up to ~6% headwind from fewer replacement opportunities given the lower amount of housing stock put in place during the recession. We also note that the potential for extended unit life discussed in the upside section earlier would mean that the housing echo replacement boom could last longer than simple calculations would suggest, but even using the Carrier definition of 18-year useful life means we turn the corner on the housing bubble in 2023, within the forecast period.

Table 64: Housing Recession Could Drive Downside in Replacement Opportunity Post 2021

2007-20 Annual Housing Completions	994,271
LT Average Housing Completions	1,397,951
Incremental Replacement Opportunity (Annual)	(403,679)
2021 Base Replacement/Add-Ons	7,234,388
Annual Replacement Opportunity (Unit Break) Downside	-6%

Source: J.P. Morgan estimates

Resi Industry Landscape: Market Share, Supplier Strategies, and Distribution Overview

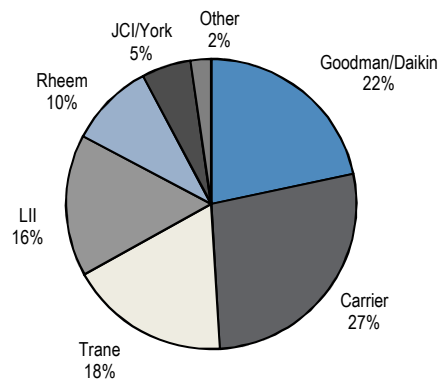
These sections provide a detailed overview of industry structure, supplier market share and strategies.

OEM Landscape and Strategies

Top six players dominate the resi market

Looking at market share on the residential side, we estimate that the top four players represent ~85% of total industry sales. Carrier and Goodman/Daikin remain the two largest players, by our estimates, with nearly half of the market between the two of them. We estimate that Trane and Lennox each have high-teens share, followed by smaller players like Rheem, York, and Nordyne.

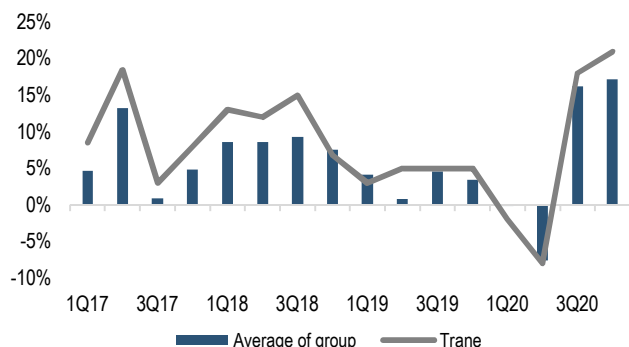
Figure 131: Residential Unitary Market Share (2020E)



Source: Company data and J.P. Morgan estimates.

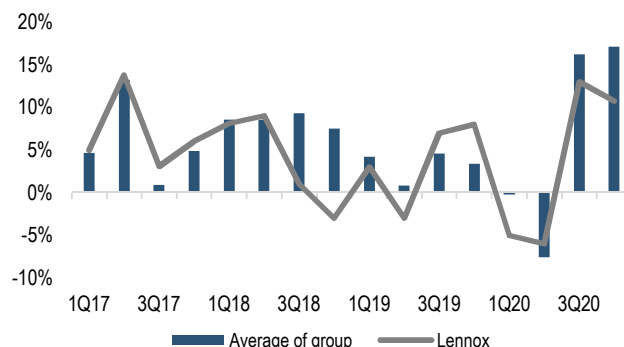
Judging by growth rates over the past 2 years, it suggests Trane and JCI have been share gainers, with Lennox also recapturing ~80% of its share loss post-Tornado in 2019 skewing some numbers there.

Figure 132: Trane vs Group Average



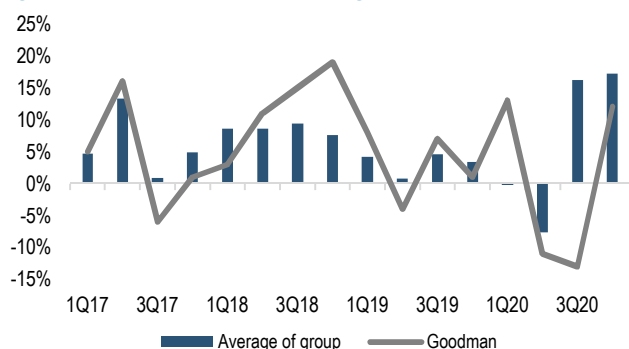
Source: Company reports, and J.P. Morgan estimates.

Figure 133: Lennox vs Group Average



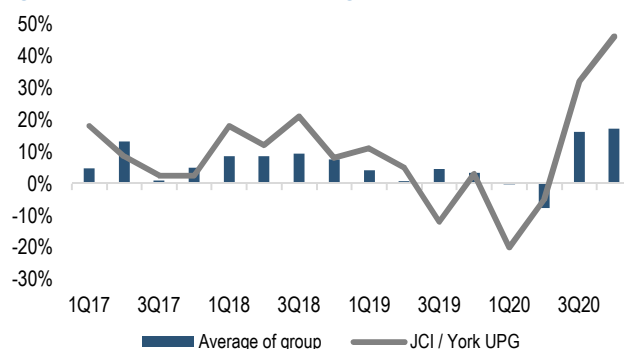
Source: Company reports, and J.P. Morgan estimates.

Figure 134: Goodman vs Group Average



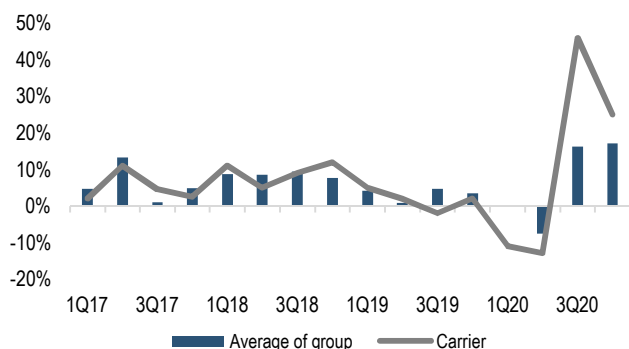
Source: Company reports, and J.P. Morgan estimates.

Figure 135: JCI/York vs Group Average



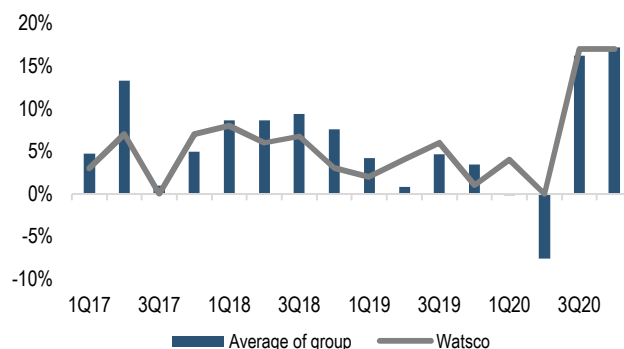
Source: Company reports, and J.P. Morgan estimates.

Figure 136: Carrier vs Group Average



Source: Company reports, and J.P. Morgan estimates.

Figure 137: Watsco vs Group Average



Source: Company reports, and J.P. Morgan estimates.

2020 a year of major shift

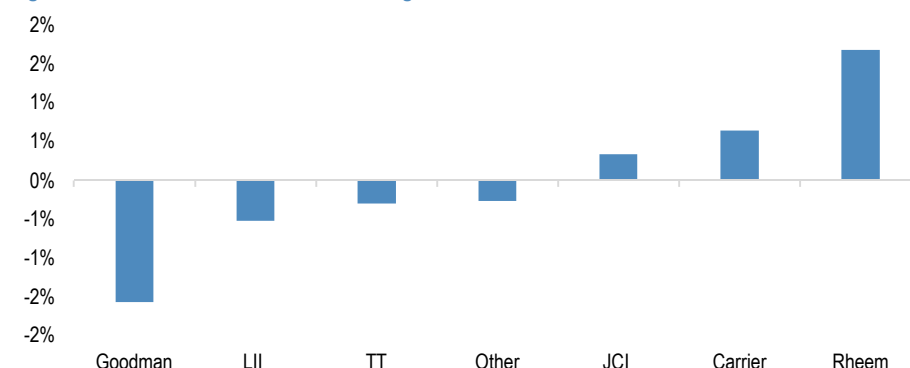
This year saw some major movement around COVID-19. Goodman, the industry leader was the biggest loser, shedding an estimated 150 bps of share which we believe was picked up mostly by Rheem. Others were in and around the flat line. Keep in mind with differing levels of captive distribution, the reported numbers don't tell the entire story, though we point to LII where both captive and independent sales were up a similar ~3% suggesting the below is representative of their performance.

Table 65: Organic Top Line Results (y/y)

	Avg	CARR	JCI	TT	LII	Daikin Americas	Notes
1Q	-5%	-11%	(>20%)	-LSD	-5%	+LT	Market up ~2% per HARDI, down ~5% for AHRI
2Q	-9%	-13%	-MSD	-HSD	-6%	-7%**	Market up ~2% per HARDI, down ~10% for AHRI
3Q	~+20%	+46%	32%	+High Teens	+13%	-13%**	Market up ~9% per HARDI, ~24% for AHRI
4Q	~+20%	+25%	46%	+>20%	+11%	12%**	Market up ~9% per HARDI, ~34% for AHRI
2020	+7%	+>10%	+LT	+MSD	+3%	~flat**	Market up ~4% per HARDI, 10% for AHRI

Source: J.P. Morgan estimates, Company data. Includes BMS controls for JCI and related services for all companies. **Ducted only, ductless up 25-30% in 3Q.

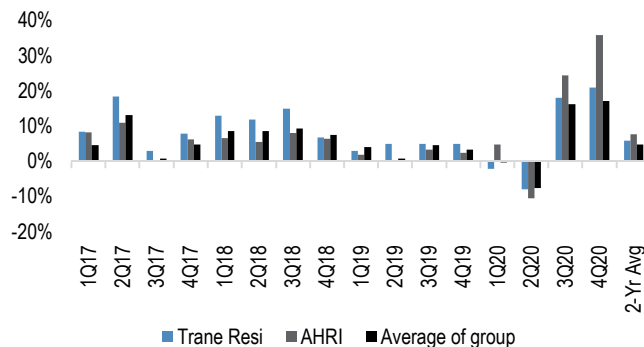
Figure 138: 2020 Market Share Shifts Using Public Data



Source: Company reports.

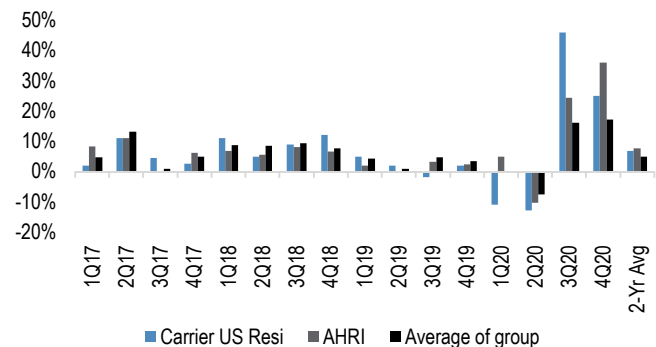
Looking at comparable growth rates, for residential, we see that Trane and JCI stand out as share gainers recently, growing HSD over the past two years versus industry average OEM growth up MSD-HSD. Lennox lost some share due to the tornado that hit its Marshalltown facility. The company now estimates that they have clawed back ~80% of their lost share there and have moved on from efforts to regain those customers and onto new customer acquisition strategies.

Figure 139: Residential Growth Rates – Trane



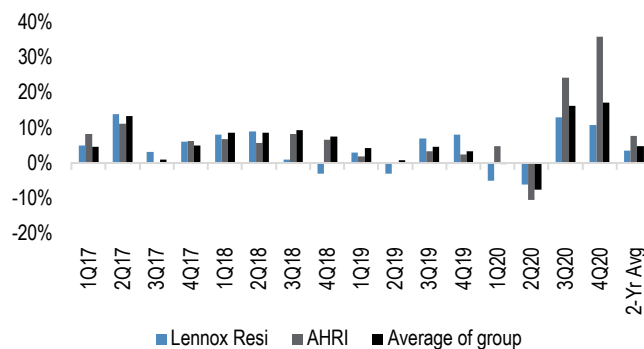
Source: Company reports, AHRI

Figure 140: Residential Growth Rates – Carrier



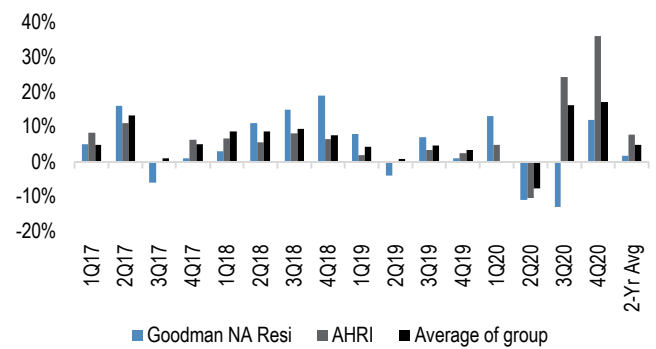
Source: Company reports, AHRI

Figure 141: Residential Growth Rates – Lennox



Source: Company reports, AHRI

Figure 142: Residential Growth Rates – Goodman



Source: Company reports, AHRI

Table 66: Residential HVAC Growth Rates

%

	2017				2018				2019				2020			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Trane Resi	9%	19%	3%	8%	13%	12%	15%	7%	3%	5%	5%	5%	-2%	-8%	18%	21%
Carrier US Resi	2%	11%	5%	3%	11%	5%	9%	12%	5%	2%	-2%	2%	-11%	-13%	46%	25%
Lennox Resi	5%	14%	3%	6%	8%	9%	1%	-3%	3%	-3%	7%	8%	-5%	-6%	13%	11%
Goodman NA Resi	5%	16%	-6%	1%	3%	11%	15%	19%	8%	-4%	7%	1%	13%	-11%	-13%	12%
JCI York UPG	18%	9%	3%	3%	18%	12%	21%	8%	11%	5%	-12%	3%	-20%	-5%	32%	46%
Watsco Equipment	3%	7%	0%	7%	8%	6%	7%	3%	2%	4%	6%	1%	4%	0%	17%	17%
Average (ex-JCI)	5%	13%	1%	5%	9%	9%	9%	8%	4%	1%	5%	3%	0%	-8%	16%	17%
AHRI	8%	11%	0%	6%	7%	6%	8%	7%	2%	0%	3%	2%	5%	-10%	24%	36%
HARDI	7%	9%	1%	6%	11%	10%	14%	13%	8%	4%	10%	3%	2%	2%	9%	9%

Source: Company reports

Brand loyalty, two-step distribution have generally limited share shifts, but recent experience and surveys suggest contractors are open to overtures
The resi HVAC industry structure has historically prevented the types of aggressive discounting seen in products like home appliances.

While OEM growth rates can vary in any given quarter, there generally are not significant near-term market share shifts in residential HVAC. Keep in mind that sales here go not just to distribution but also to licensed contractors, most of whom have historically been brand loyal, limiting the degree of consumer discretion on brand selection. Indeed, many dealer-contractors will offer just one to two brands (often a “value” and a “premium” brand), which they will know well and consistently

pitch to homeowners. Only in extreme scenarios, such as 2011, when Trane did not offer R-22 dry ships and forced its dealers to look elsewhere. However, recently there have been some notable shifts in share. Since 2018 when LII was hit by the tragic tornado, they lost close to a point of market share, and while they bounced back the year after, they admittedly only recaptured about 80% of what they lost. Goodman in this most recent year lagged the market materially, losing what we estimate to be about a couple points of share, and the strategy for recapture is unclear. While brand is important to a contractor as it is essentially vouching for the quality of the product over the lifetime of the system, reducing incentives to experiment with a cheaper but untested manufacturer, recent surveys suggest they are open to overtures from competing OEMs when a "selling event" occurs. As we will show later, a recent HARDI survey found that contractors see product availability / inventory levels as the most important attribute when selecting a distributor to purchase from, with brand not even making it into the top 3.

Table 67: What is Most Important to Contractors When Selecting a Distributor

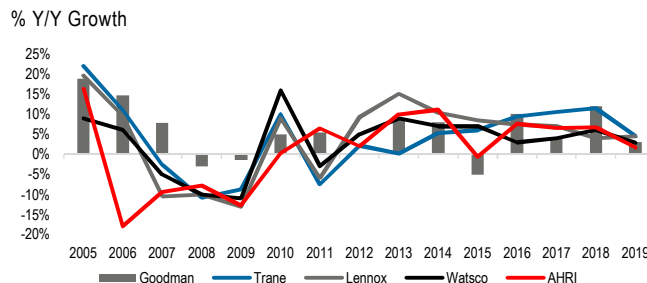
Rank	Category
1	Product availability / inventory levels
2	Pricing
3	Delivery service (timely & accurate)
4	Equipment manufacturer brand represented
5	Local technical / field service support
6	Outside salesperson presence & relationship
7	Warranty
8	Counter / will call service
9	Training provided
10	Location
11	Credit terms / Flexibility
12	E-Commerce / Online ordering capabilities
13	Dealer Benefits / rewards program

Source: HARDI.

Goodman the primary share gainer in 1990-2005 period, helped by 13-SEER transition

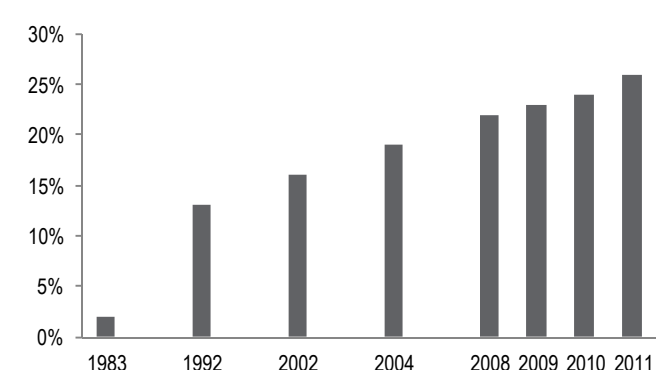
Goodman is the one company that has gained a material amount of market share over the past 20+ years, going from 12-13% share in 1992 at ~25% today.

Figure 143: Goodman Outperformed Through the 13 SEER Transition and the Most Recent Downturn...



Source: Company reports, J.P. Morgan

Figure 144: ... Driving Consistent Market Share Gains

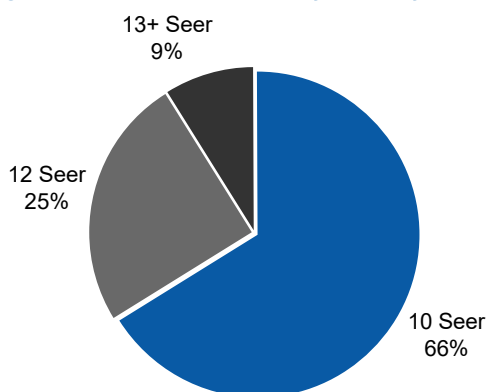


Source: Company reports, J.P. Morgan

To be sure, Goodman has done plenty right, including what is considered by many to be best-in-class design and manufacturing efficiency. It is also notable, however, that

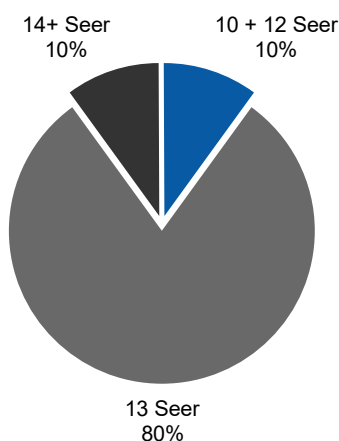
in both the 1992 and 2006 regulatory transition periods, the premium niche segment of the HVAC market became more commoditized, effectively expanding the opportunity for a value product. Goodman is the key player in the value market and was able to take advantage of this shift.

Figure 145: 2005 Estimated Industry Efficiency Mix



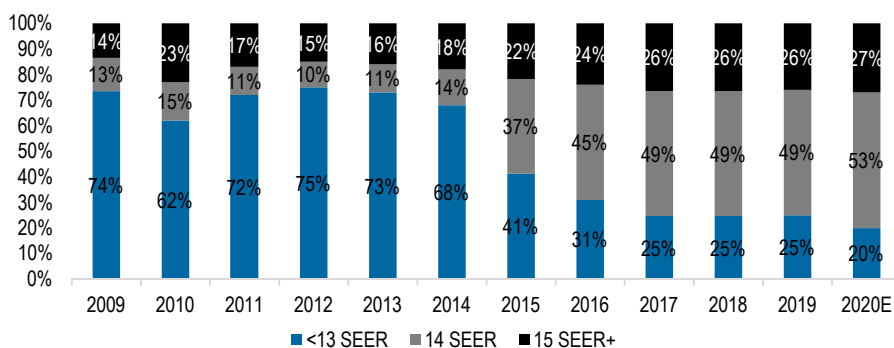
Source: AHRI.

Figure 146: 2006 Estimated Industry Efficiency Mix



Source: AHRI.

Figure 147: JPM SEER Estimates Over Time



Source: J.P. Morgan estimates, Company data.

“Good, better, best” had been the traditional model . . .

Historically, most OEMs have migrated to a “good, better, best,” model, offering the full spectrum of products to meet customer demand. This is true even of players like Goodman, which have focused on the low-end units but still offer high-efficiency products.

Table 68: Most Manufacturers Adopt a Good, Better, Best Model

	Carrier	Goodman	Lennox	Trane
Good	Payne	GMC	Allied Brands	Ameristar/Oxbox
Better	Bryant/Tempstar/HEIL	Goodman	Allied/Lennox	American Standard/Trane
Best	Carrier	Daikin	Lennox Brands	American Standard/Trane

Source: Company reports and J.P. Morgan

. . . though middle tier products have been increasingly squeezed out . . .

In recent years, however, we think the market has squeezed the share of mid-level product, with demand concentrating either on the low end of the market (seen in Goodman’s increased share, Trane’s introduction of a more affordable Oxbox unit)

or on the high end of the market (seen in the growth of 16+ SEER). Drivers here include the ongoing increase in minimum efficiency standards, which blur the line between low- and mid-level products. Therefore, product lines at the OEMs have become more bifurcated, with an emphasis just on “good” and “best.”

... and the distinctions between “premium” and “value” are blurring

There are also some recent tweaks to OEM strategies that are beginning to blur the lines between traditional “premium” players like Lennox/Trane and “value” players like Goodman. Increasingly, we would expect the major OEMs to become more similar than different, with all major brands having competitive products across the spectrum of SEER ratings. We highlight the recent strategic changes from a few OEMs, specifically:

- Trane— Starting in 2012, Trane launched an Ameristar brand targeted at the value portion of the market (primarily 13/14 SEER); however, it plans to launch products up to 16 SEER under the same brand. The strategic goal is to better address the low end of the market, particularly following 2011, when Trane had limited R-22 product and saw disruptions among its core dealers. While reinforcing their position at the high end with the Trane (captive distribution brand) and American Standard (independent distribution brand), they more recently introduced the Oxbox, presented as an “affordable” unit. Commentary and above market growth trends suggest that investments in technology and sales/service are going well.
- Goodman/Daikin—Goodman has historically been a very strong competitor on the low end of the market, something that hasn’t changed under Daikin’s ownership. However, Daikin also brings competency in high-efficiency VRF systems and inverter compressors, and it has begun implementing a strategy to more aggressively attack the full spectrum of the market. It has introduced some Daikin-branded residential ducted systems in the >16-SEER range, while we also expect a refocus on the >14-SEER Goodman-branded unitary product. They also introduced the “Fit” hybrid system, which looks promising to us, leveraging their already strong footprint in ductless. The company is going through a transition, attacking the high end of the market and acknowledging that the cost advantage that it has widely enjoyed over the past two decades on the value side has probably gone as far as it can, a key aspect of the new fully automated factory, which represents the next layer of capacity and efficiency.
- Lennox—Lennox has always had offerings of both value brands (Allied, sold through independent distribution) and the Lennox-branded higher end products (sold through captive distribution); however, the company had historically been known as more of a premium player as Allied brand makes up only ~20% of total shipments. In recent years, the company has increasingly focused on more cost-competitive products for 14 SEER at both Lennox and Allied-branded products, something it believes has helped diversify its product lineup and gain share. As the 2023 efficiency regs near, they are launching a 28 seer for Resi (SL 28cv), which will be their most energy efficient and precise A/C, utilizing a variable-capacity inverter compressor.
- Rheem— Rheem makes HVAC (#5), water heaters (#1 or #2) and some refrigeration products, and the company is larger than Lennox in size and presumably similar to Lennox and AO Smith in profitability. They are owned by private Japanese consumer products company Paloma. Rheem globally is more than 50% water heating, while Rheem Americas is approximately evenly split between HVAC and water heating. Rheem sales mix tends to skew more heavily

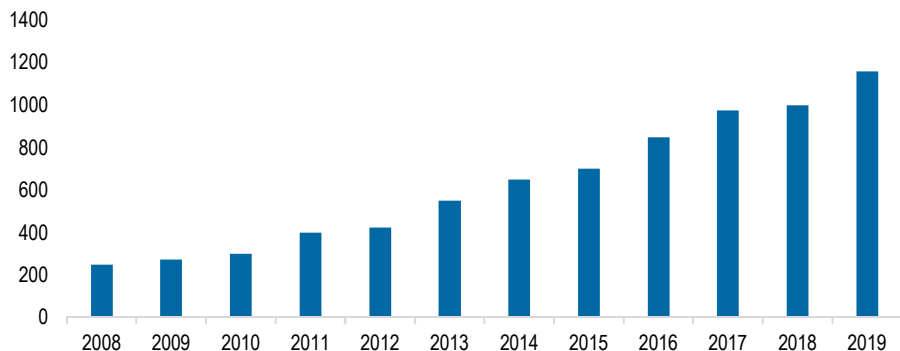
to Residential relative to its competition, but they have and continue to make significant investments in Commercial HVAC and water heating. Since the great recession, Rheem has invested almost \$1B to completely refresh their residential and light commercial product lines, expand their manufacturing capabilities, and introduce new technology platforms and systems across its business segments. For example, they have already made investments in a highly automated factory in Arkansas for light commercial unitary products. On this front, they have a new platform, with remaining models launched this year, around which contractors participated in the design, with the main features better serviceability and the industry standard footprint, the Carrier “curb” which can cost an extra couple thousand for the contractor to fit and mirroring strategies seen at others. They are also investing heavily in brand new residential platform ahead of the 2023 regulations. They have partnered with Fujitsu and they have a hybrid launched. They have also completed several acquisitions to expand their product range and geographical reach. They are 100% independent distribution in US HVAC, with Watsco and Ferguson being their largest channel partners. The Home Depot is their largest channel partner in water heating. We have been hearing more positive things from the marketplace on Rheem for some time, and are impressed with the strategy/execution and recent degree of portfolio refresh here. They have been growing significantly over the past several years and have increased their market share positions in almost all business segments. They view their water heating expertise as a differentiator as they are the only major player with products that integrate air and water. Judging by their footprint which is almost 100% in Mexico, we assume that profitability here is amongst best in class.

Ductless mini-split growth continues, but starting to get closer to full penetration

Ductless residential mini-splits continue to grow off of a low base in North America, a dynamic that we think represents the biggest structural change over the next few years, though this is still a niche market that is getting closer to full penetration and 2018 showed some deceleration, as shown in the chart below. This technology has been pioneered by Asian players, and offers several advantages over traditional ducted residential systems, including greater efficiency, but offset by higher costs and aesthetic hurdles. While resi mini-splits remain somewhat of a niche, regionally concentrated product at ~10% of the market, we think outgrowth continues over the medium term and ductless market share settles at around 15% of the market. US OEMs are building out their ductless capabilities and partnering with Asian players to bring this technology to the North America market. However, most OEM efforts are focused primarily on the commercial VRF space, while resi mini-splits continue to be dominated by Asian companies. In this report, we do a deep dive on the US ductless market (both resi and commercial), but since US OEM strategies are primarily aimed at commercial applications, we include this analysis in the Commercial HVAC section.

Figure 148: Mini Split Market

Thousands of units



Source: JARN

Regulatory Changes A Big Driver: Efficiency and Refrigerants

SEER

SEER shift in 2023 should keep mix moving up as a driver of revenue and cause some pre-buy in 2022

New efficiency standards set by the DOE on residential ACs and heat pumps are coming in 2023, driving OEM investment over the next several years. Minimum residential efficiency levels for central ACs under 45,000 Btu/hr would be 14 SEER in the North and 15 SEER in the Southeast and Southwest, and for over 45,000 Btu/hr, would be 14.5 SEER in the Southeast and Southwest, and 14 SEER in the North. Heat pump efficiency levels would be set at 15 SEER for all regions. These new efficiency standards are expected to bring an 8-10% increase in efficiency according to EMR, while on the commercial side, systems will move to level EL3 (15% increase in minimum efficiency).

Table 69: New efficiency standards approved by ASRAC

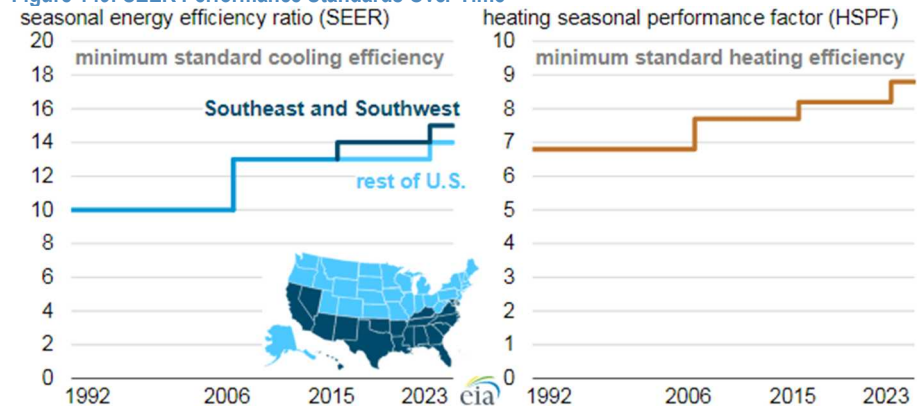
Product class	National	Southeast	Southwest
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	SEER	HSPF	SEER	SEER	SEER
Split-system air conditioners with a certified cooling capacity of <45,000 Btu/h	14		15	15	12.2/10.2
Split-system air conditioners with a certified cooling capacity of > or = 45,000 Btu/h	14		14.5	14.5	11.7/10.2
Split-system heat pumps	15	8.8			
Single-package air conditioners and heat pumps	14	8.0			11.0

Source: ACHR News

The last time a significant regulation change was seen in SEER was in 2006, with a smaller change implemented in 2015 as well. Below we see the changing standards over the past ~30 years.

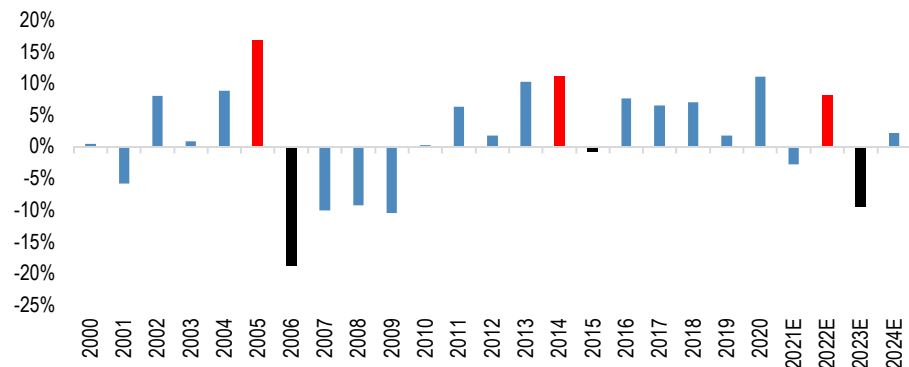
Figure 149: SEER Performance Standards Over Time



Source: EIA

Looking at the last two times there was a SEER regulation change, we see a clear bump in the year prior due to pre-buy dynamic with distributors looking to increase inventory prior to the regulation taking effect. In 2005, we see a y/y increase in resi shipments of 17%, compared with an average of just 2% y/y growth for the 5 years prior from 2000-2004. This spike is followed by a 19% decline in 2006 when the regulation took hold. Similarly, but not to the same degree, in 2014 we see an 11% y/y increase in unitary shipments, compared with an average of 2% for the preceding 5 years (2009-2013) and followed by a 1% decline y/y in 2015 the year the regulation took effect. While the magnitude of the headline SEER change is more in line with what happened in 2014, the testing standards this time around are more stringent, which means higher cost of system and likely a higher level of pre-buy, yet not to the degree of what we saw in '05/'06. Accordingly, we model 8% y/y growth in 2022 due to this pre-buy dynamic, compared with a ~4% y/y average for the preceding 5 years (2017-2021) and followed by a 10% decline in 2023 the year of the regulation implementation and 2% growth in 2024.

Figure 150: Resi Unitary Shipments: Pre-Buy Dynamic seen in Red



Source: J.P. Morgan estimates, Company data.

Refrigerants

Refrigerants are a key component of an HVAC system (~5% of total cost) as they provide the function of cooling the evaporator coils. Historically, there were a dozen or more suppliers of R-22 refrigerants, but with the switch to R-410a, there are now only a handful of manufacturers, which include Honeywell (leading share), Chemours, Daikin and Arkema. Below, we discuss the ongoing transition towards a next generation of low GWP and non-ozone depleting refrigerants, and provide a summary of the types of refrigerants currently used in the industry in the appendix.

Regulatory environment set a 2023 deadline in CA, looks to be getting pushed back to 2025 and made national

A key trend in the refrigerant market is the transition coming in 2023, recently pushed back in California to 2025, and made its way into a national discussion as part of the AIM stimulus bill. In the U.S., there is no federal mandate around refrigerant regulations due to uncertainty around the Kigali Amendment on HFCs, as President Trump has held off on backing the international agreement to reduce the use of potent greenhouse gases in AC and refrigeration, ratified by 60 countries. However, U.S. states are adopting lower GWP refrigerants themselves and passing SNAP rules into law, with California's ruling banning R410A in new equipment by a 2023 deadline, as well as proposals from other states like Maryland and Maine. According to EMR, this is driving an "unprecedented" amount of new product work across their compressor businesses as OEMs redesign systems for the new refrigerants. Indeed, OEMs will have to develop their new unit models around new refrigerants, and which refrigerants they choose as primary LGWP solutions to replace R410A will be a key watch item over the years as systems need to be designed soon, and with most of the industry development dollars to be spent on this. In May, the EPA pre-published SNAP rule 23, which would allow the use of A2L refrigerants in new residential air conditioners and heat pumps only. These refrigerants cannot be retrofitted into existing equipment. A2L refrigerants are mildly flammable and include R-454B and R-32. More recently, California became the first state to adopt regulations that will phase down the use of HFC refrigerants in commercial and industrial stationary refrigeration units, such as those used by large grocery stores, as well as commercial and residential A/C equipment. Under these new rules, starting in 2022, there is a 150 GWP limit for new or fully remodeled facilities that utilize commercial refrigeration equipment containing more than 50 pounds of refrigerant; there are varying requirements for existing facilities. The 750 GWP limit for many types of air conditioning equipment, however, was pushed back from 2023 to 2025, while VRF system manufacturers have until 2026 in order to

comply with the new limit given that current building codes and standards do not allow the use of lower flammability (A2L) refrigerants in equipment.

However, recently, as part of the AIM Act, authorizes the US Environmental Protection Agency (EPA) to regulate a group of 20 substances known as HFCs. The AIM Act supports the transition to next generation refrigerant technologies in 3 ways. First in HFC production, production and consumption is phased down over a 15-year period via a closed allowance allocation and trading program, providing an orderly and market and consumer friendly transition from HFCs. Second the EPA is authorized to establish standards for the management of HFCs used as refrigerants such as in equipment servicing and repair, and the recovery of "used" HFCs for purification and resale, known as reclaim. This helps ensure an adequate supply of HFCs for servicing existing equipment. Third, EPA can establish sector-based use restrictions, as a way to facilitate transitions to next generation refrigerant technologies. These restrictions would complement the broader production and consumption phase down, aiding sectors able to transition more quickly away from HFCs and providing more flexibility for sectors in need of more time to complete a transition. The act complies with the Kigali Amendment and increases U.S. supply to global HVACR markets by \$5 billion. The phasedown is based on a baseline from 2011-2013 reaching 15% of the baseline by 2036.

Increasing use of alternatives to R22 and R410A: R32, Solstice L-41, and recently unveiled refrigerants ahead of 2023 deadline

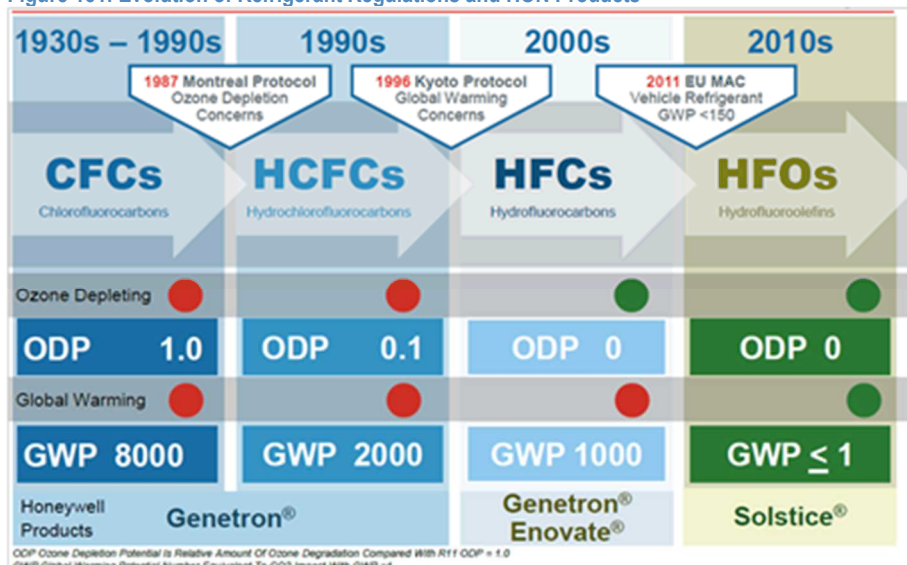
R410A has been the dominant choice of refrigerant in developed countries including Japan, the United States, and European countries ever since the phase-out of R-22 started. However, a lot of developing countries are still using R-22 as a primary refrigerant. Some of these countries that have started to phase out R-22, rather than transitioning to R410A, and are contemplating shifting to a further lower GWP (global warming potential) refrigerant, like R32 and L-41 (proprietary, developed by Honeywell). These refrigerants can also be used as easy alternatives to R410A as they require minimum changes to the existing equipment, unlike an R-22 replacement.

Table 70: L-41 vs. R32 vs. R410A

Refrigerant	Alternative to	GWP (CO2 = 1)	Flammability	Blend	Discharge Temperature
R-410A	R-22	2088	Non-Flammable	R32 and R125	Relatively Low
L-41	R-22,R410A	500	Mildly Flammable	R32 and HFO1234ze	Relatively Low
R-32	R-22,R410A	675	Mildly Flammable		Relatively High

Source: JARN, ACR, Honeywell.

Figure 151: Evolution of Refrigerant Regulations and HON Products



Source: Company reports

In 2013, Japanese A/C manufacturer Daikin was the first leading manufacturer to launch an air conditioner using R32 refrigerant, with initial introduction in Japan, and is making its way into other regions such as the U.K. with Goodman, as well as Australia, India, and Europe. On the other hand, Honeywell has also made major investments to produce the L-41 refrigerant, a proprietary refrigerant that is likely a blend of HFO-1234ze (Solstice ze) and R32, offering superior efficiency, better cost effectiveness, and has a lower GWP than R32 and R410A.

Table 71: Honeywell Solstice HFO Blends for HVAC Applications

Current Product	Solstice N Series Reduced GWP Option and Non Flammable	Solstice L Series – Lowest GWP Option and Mildly Flammable
R-22	N-20 (GWP ~1000)	L-20 (GWP ~350)
R-410A		L-41 (GWP ~500)

Source: Honeywell.

Following the California ban on R-410A, Chemours and Honeywell have also unveiled new refrigerants in the last year, with an even lower GWP for Chemours and a non-flammable aspect for Honeywell. Chemours has already opted for the mildly flammable R454B (A2L ASHRAE classification) for its Opteon XL41 blend, which was selected by Carrier for its unitary products in North America (ducted residential and light commercial packaged solutions), while Honeywell chose the non-flammable R466 (preliminary A1 classification). Chemours' Opteon XL41 refrigerant (R-454B) is expected to surpass requirements of anticipated future regulations. It has a GWP of 466 (one-fifth of the R-410A) and is composed of 69% R-32 and 31% R-1234yf. While the industry is moving to A2L refrigerants (mildly flammable), HON's R466A could change that as the first non-flammable alternative offered to R32, unveiled last June as the Solstice N41 and commercially available in 2020. Its composition of 9% R32, 11.5% R125 and 39.5 % CF₃I offers ~60-65% lower GWP with more energy efficiency. The Solstice N41 (R466A) features a reduced GWP of 733 and is designed to replace R410A with a GWP of 2,090. This technology is suitable for room air conditioners, packaged air conditioners, and commercial air conditioners such as VRF systems, as well as heat pumps. Refrigerants for mini-split applications are still a TBD, for which non-flammable

characteristics are more important given the greater movement of refrigerant, but Honeywell believes N41 is more suitable for VRFs than other alternative candidates for R410A thanks to its non-flammability.

Table 72: Refrigerant Replacement Options to R-410A

Refrigerant	Manufacturer/Product	Flammability	Global Warming Potential (GWP)	Characteristics
R454B	Chemours/Opteon XL41	mildly flammable	~80% lower than R-410A	requires additional sensors on installation due to flammability; more "plug and play" from an equipment & supplier assembly/manufacturing perspective
R466A	Honeywell/Solstice N41	non-flammable	~60-65% lower than R-410A	easily convertible; requires minimal equipment changes and no additional training for installation techs; some compatibility problems with certain materials
R32	various	mildly flammable	33% less than R-410A	relatively high discharge temperature; additional sensors required on installation

Source: Company reports, JARN

Previously, R32 had become the LGWP refrigerant of choice for smaller AC systems as a medium-term alternative to R410A, but its mildly flammable aspect makes it unsuitable for larger systems. R32/454B will require extra sensors throughout the building on installation while R466 wouldn't, but according to our conversations at AHR, R32/R454B are more "plug and play" from an assembly and manufacturing perspective, while the R466 faces hurdles around working with certain materials and could require additional design tweaks. Therefore, while HON's solution is the best proposition as advertised (the only non-flammable offering), there is still some work to do on developing a package that works with key system components to improve the "plug and play" nature. Indeed, and somewhat curious on timing, Carrier, the first OEM to commit, is going with Chemours for its solution in ducted products, despite its flammability, which means added sensing apparatus in the home/building, given more limited need for re-designs throughout the supply chain. Still, HON said that its design provides for less complexity in system installation, with minimal changes to equipment and no additional training for installation and repair technicians, allowing OEMs to easily convert from R-410A. They also cited lower costs of transitioning to Solstice N41 compared to converting to a flammable refrigerant. Although the refrigerant remains in trials (>10,000 hours of testing) and needs work around packaging and system to work with system components, Daikin expects non-flammable refrigerants to win out. In recent news, the latter also said that it was employing AI technology to develop a new mildly flammable refrigerant (A2L) with GWP of 10 or less, to be introduced in 2023. On the OEM customers' side, HON believes OEMs will be able to choose to work with more than one refrigerant, and Carrier indeed left the option open for its other types of equipment (such as VRF) and said it will select the best suited refrigerant as the need arises. Lennox is holding off on making a call between R454B and R32, and mentioned hearing of shortfalls on capacity rates during tests of R466. EMR cited seeing a lot of competing refrigerants, and they see themselves as well positioned to lead through the transition as they boost their sampling and prototype activity to support OEMs' resource shift. The table below provides a summary of the standard low-GWP alternative refrigerants and their applications and brand names.

Table 73: Typical Low-GWP Alternative Refrigerants/Applications

Refrigerant	Flammability	GWP	Alternative to	Application	Manufacturer	Brand Name
R466A	A1	733	R410A	ACs/Heat Pumps	Honeywell	Solstice N41
R463A	A1	1377	R410A, R404A	ACs/Low-temp equipment	Chemours	Opteon XP41
R407H	A1	1378	R404A	Low-temp equipment	Daikin	Creard
R448A	A1	1387	R404A	Low-temp equipment	Honeywell	N40
R449A	A1	1282	R404A	Low-temp equipment	Chemours	XP40
R452B	A2L	676	R410A	ACs/Heat Pumps	Honeywell	L41y
R454B	A2L	467	R410A	ACs/Heat Pumps	Chemours	XL55
R1233zdE	A1	1	R123	Centrifugal Chillers	Honeywell	Solstice zd
R1234zeE	A2L	<1	R134a, R410A	ACs/Chillers	Honeywell	Solstice ze
R514A	A1	2	R123	Centrifugal Chillers	Chemours	XP30
R1224ydZ	A1	<1	R245fa	Centrifugal Chillers	AGC	AMOLEA

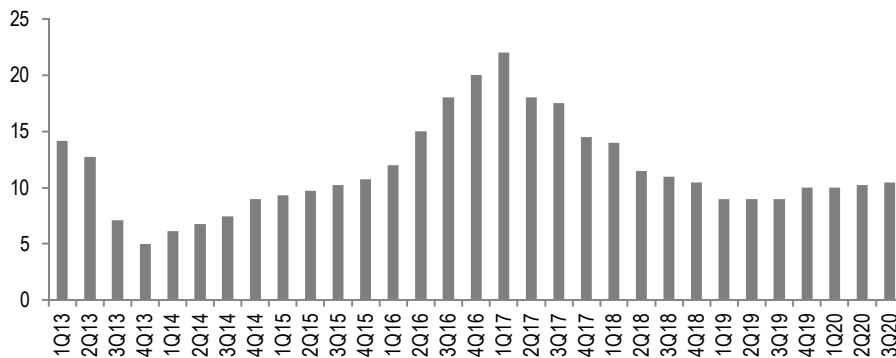
Source: JARN. Note: A1 = non-flammable; A2L = mildly flammable

Honeywell, a leading supplier: Honeywell is a leader in the refrigerant business, along with companies like Chemours, and saw significant growth in 2010 driven by (1) the conversion to R-410a in the US, where it has a much higher market share than for R-22 refrigerants, and (2) growth in international markets like China. R-410A was initially developed and patented by Allied Signal, which is now part of Honeywell, in 1991. Over time other manufacturers have gained license to manufacture and sell this refrigerant, but Honeywell is still the leader from both a capacity and sales point of view. HON's Solstice line of refrigerants is experiencing rapid growth in the DD+ range over the past few years as penetration increases and the company maintains a dominant market presence, including the first non-flammable alternative to R-410A introduced to the market, available commercially in 2020. The non-flammability aspect is important as it is required for larger systems and applications such as VRF, roof-top and split air-conditioning units, and thus it is well positioned for growth on conversion of the stationary A/C market as an alternative to R-410A.

Although we are not aware of any direct, regular pricing on R-22 gas, feedback from the channel and major R-22 producers showed that pricing generally rose from 2H14 to 1Q17, and has trended down since. Hudson Technologies (a company that offers recovery and reclamation of refrigerants) reported a price increase of ~20% for R-22 following the final EPA ruling and reported further increases throughout 2015 and 2016. 2017, however, saw steady declines throughout as the company cited disruption from a competitor aggressively putting new product into the market. In 2018, R-22 pricing continued its downward trend from \$14-15 per pound in 4Q17 to ~\$11-12 in May, to \$10-11 in August (HFC pricing down 40% q/q in 2Q) and remained in that range through December, according to Hudson. In March 2019, R-22 pricing was down further to \$9 per pound, and as of the end of the summer selling season in 2020 it has moved back up above \$10. For Honeywell, while not a dramatic needle mover, higher R-22 pricing is generally a tailwind for PMT margins, while lower prices are a headwind. Recall that in 2012-13, R-22 spiked on rumors of an aggressive phase-down, only to collapse shortly thereafter, with a negative impact on margins for PMT. While HON was a meaningful R-22 player, the company continues to roll out new refrigerants that could lead the transition into 2023, and we also expect HON's Fluorines business to continue to deliver above average growth in the intermediate term with visible opportunities in mobile, commercial refrigeration, stationary A/C, and other applications.

Figure 152: Estimated R-22 Refrigerant Prices (Industry Average)

\$/lb



Source: Hudson Technologies, J.P. Morgan estimates

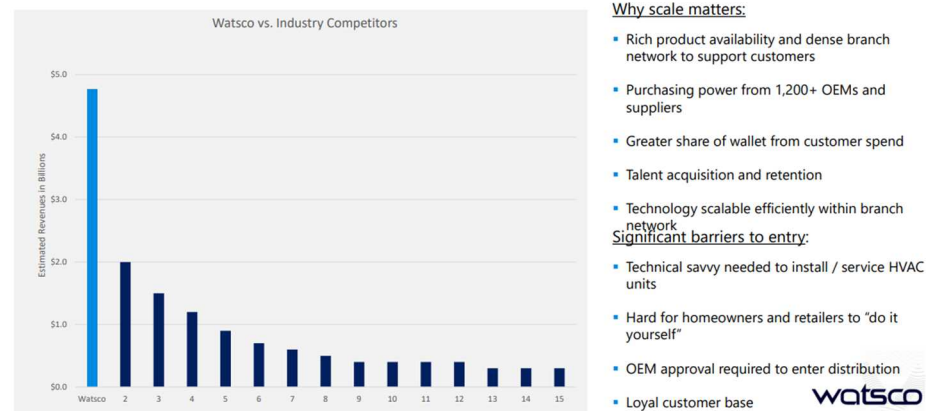
Honeywell continues to highlight the secular growth trends it is seeing in Solstice as it expands its LGWP applications, with investments driven by environmental regulations. The total Fluorines business is now ~\$1.6B, or 60% of Advanced Materials, with refrigerants and foams representing 17% of PMT. We estimate that Solstice has ~\$1B of sales. At its 2019 Investor Day, management said it expects a 15% CAGR in Solstice with acceleration of HFO solutions providing for expansion to a \$7B total addressable market, driven by the conversion of the stationary AC market with N41, and entry into adjacent verticals (personal care, XPS foam). Sales of low GWP refrigerants are being driven by regulatory changes, and a phase-out of legacy HFC refrigerants used in refrigerators, cars, and air-conditioners worldwide has created a lucrative opportunity for Honeywell. A shift in the market also helps in the near to mid-term as HON products are under patent protection into the next decade, which should lead to solid margin expansion given high competition and low margins for legacy business with expiring patents.

HON has developed both medium term (<750 GWP) and long term (<150GWP) refrigerants for most systems and applications for ACs (heat pumps, split AC, VRF and rooftop units, chillers) and refrigeration (food service, stores, supermarkets), with solutions either already available or pending but already developed. They have successfully launched a non-flammable low GWP solution for chillers which is being adopted by a wide range of manufacturers. They are having active dialogue with customers and working with the regulatory bodies in developing new refrigerant solutions for a variety of air conditioning and refrigeration applications, including commercial, residential, transport, and small self-contained. These new solutions represent an opportunity to displace HFCs in a variety of markets, including stationary, representing an additional \$6B TAM expansion through 2022. They have previously talked about rolling several new solutions over the next few years, and have so far presented their new Solstice N-41 refrigerant for ACs (split and VRF/rooftop) and chillers (mid-high pressure), and introduced SGWP molecules into personal care solutions, where they are seeing good traction and growing fast. They also launched the Solstice L41y refrigerant in Sept 2018, a reduced GWP refrigerant for reversible air cooling and heating applications, with lower price and 67% lower GWP than R-410A, and 5% higher efficiency than R-32. This solution is commercially available in Europe for chillers and heat pumps. For Refrigeration systems, they see a need to shift the focus towards the combination system and the refrigerant, instead of the refrigerant only, as systems are evolving based on the refrigerant, and there is no single refrigerant solution for all applications.

Distributors: Watsco remains the leader

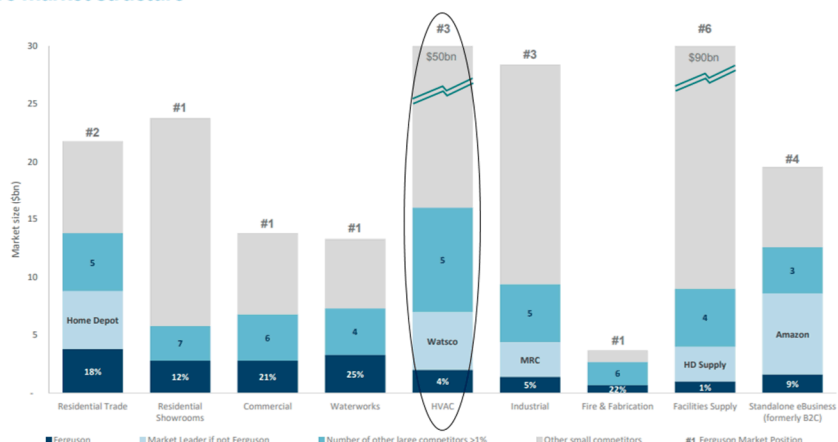
Watsco is the leading player in the HVAC distribution industry garnering market share of just ~10-15%, leaving plenty of room for future industry consolidation. Outside of the OEM-owned locations, HVAC distribution is still generally a mom-and-pop business, with many distributors having been in business for decades, and the businesses passed down through generations. As background, Ferguson estimates the industry is \$50 B in size, while the average size of a distributor is just in the tens of millions of dollars (>2,000 independent distributors), with very few distributors with significant scale (see table of Top 50 distributors below). Note that even at the bottom of the list of the Top 50, HVAC/R-related sales are generally \$100mm or less.

Figure 153: Watsco a Leader in a Fragmented Market



Source: Company reports

Figure 154: Ferguson View of the HVAC Market Size
USA: a diversified but connected business with attractive market structure



Source: Company reports

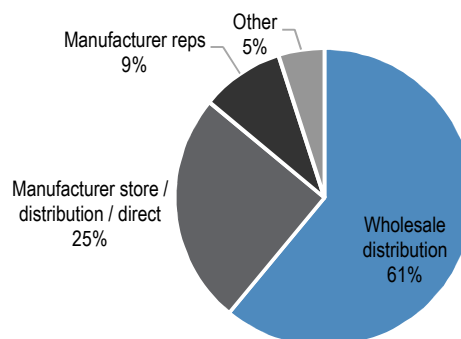
Table 74: Ranking of Top 50 HVAC/R Distributors (2019 ranking, 2018 data)

Rank	Company	Size (\$ in mm)	City	State	# locations	# Employees	% Sales HVACR	% Refrigeration
1	Watsco Inc.	1000+	Miami	FL	572	5300	100%	5%
2	Johnstone Supply Inc.*	1000+	Portland	OR	424	4586	100%	10%
3	Ferguson Enterprises*	1000+	Newport News	VA	1459	24000	12%	2%
4	R.E. Michel Co.*	>250	Glen Burnie	MD	290	1980	92%	2%
5	Sigler Wholesale Distributors*	>250	Tolleson	AZ	32	721	100%	0%
6	Winsupply*	>250	Dayton	OH	600	6300	18%	2%
7	Mingledorff's Inc.*	>250	Peachtree Corners	DE	38	550	99%	0%
8	F. W. Webb Co.*	>250	Bedford	MA	90	2400	35%	11%
9	US Air Conditioning Distributors	>250	City Of Industry	CA	50	475	100%	0%
10	Habegger Corp., The*	>250	Cincinnati	OH	35	450	95%	0%
11	Munch's Supply*	>250	New Lenox	IL	27	520	100%	0%
12	Temperature Equipment Corp.*	>250	Lansing	IL	33	475	100%	2%
13	Gustave A. Larson Co.	>250	Pewaukee	WI	52	430	100%	19%
14	ABCO HVACR Supply + Solutions	150-250	Long Island City	NY	17	310	100%	24%
15	Peirce-Phelps Inc.*	150-250	Blue Bell	PA	21	280	93%	3%
16	MORSCO*	150-250	Addison	TX	210	2700	10%	5%
17	Sid Harvey's	150-250	Garden City	NY	75	425	100%	21%
18	Koch Air*	150-250	Evansville	IN	9	215	100%	0%
19	Century Holdings/Century A/C Supply	150-250	Houston	TX	32	296	100%	2%
20	Hercules Industries*	150-250	Denver	CO	20	524	99%	1%
21	G.W. Berkheimer Co.*	150-250	Portage	IN	27	387	100%	0%
22	Auer Steel & Heating Supply Co.*	150-250	Milwaukee	WI	8	245	87%	2%
23	Value Added Distributors	150-250	Midlothian	VA	19	190	100%	0%
24	Famous Enterprises*	150-250	Akron	OH	39	800	45%	0%
25	Lohmiller & Co./ Carrier West*	95-150	Denver	CO	4	174	100%	0%
26	AC Pro*	95-150	Fontana	CA	16	405	100%	0%
27	Huntton Distribution	95-150	Houston	TX	4	120	100%	0%
28	Behler-Young*	95-150	Grand Rapids	MI	18	215	100%	3%
29	Shearer Supply*	95-150	Farmers Branch	TX	15	162	100%	0%
30	American Refrigeration Supplies Inc.	95-150	Phoenix	AZ	31	208	100%	50%
31	Corken Steel Products Co., The*	95-150	Florence	KY	15	280	100%	1%
32	Locke Supply Co.*	95-150	Oklahoma City	OK	168	1100	28%	0%
33	Coburn Supply Co.	95-150	Beaumont	TX	54	970	31%	6%
34	Johnson Supply	95-150	Houston	TX	24	214	100%	8%
35	Refrigeration Sales Corp.*	95-150	Valley View	OH	11	138	100%	13%
36	Conklin Metal Industries*	95-150	Atlanta	GA	12	180	100%	0%
37	Goodin Co.*	95-150	Minneapolis	MN	15	465	50%	8%
38	CCOM Group Inc.*	95-150	Hawthorne	NJ	17	180	92%	0%
39	S.W. Anderson Sales Corp.*	<95	Farmingdale	NY	10	160	93%	2%
40	American Metals Supply Co. Inc.*	<95	Hazelwood	MO	8	110	100%	0%
41	Young Supply Co.	<95	Chesterfield Twp	MI	17	192	100%	40%
42	HVAC Distributors Inc.*	<95	Mount Joy	PA	14	155	100%	1%
43	Epting Distributors Inc.*	<95	Lexington	SC	13	130	100%	0%
44	APR Supply Co.	<95	Lebanon	PA	36	315	60%	2%
45	Williams Distributing Co.*	<95	Grand Rapids	MI	25	400	100%	0%
46	Charles D. Jones Co.*	<95	North Kansas City	MO	19	150	85%	10%
47	S. G. Torrice Co.*	<95	Wilmington	MA	11	125	100%	0%
48	Design Air*	<95	Kimberly	WI	8	140	100%	0%
49	Minnesota Air Inc.*	<95	Bloomington	MN	4	78	100%	0%
50	Granite Group, The*	<95	Concord	NH	35	507	29%	0%

Source: Distribution Center Magazine

According to HARDI, wholesale distribution represented 61% of HVACR channel share in 2020, more than 2x the size of the next biggest channel (manufacturer store/distribution/direct), and up from 60% share in 2019. The market is split roughly evenly between residential and commercial HVACR products. Contractor demand for residential is estimated to have grown 2-3% in 2020, with close to 10% growth in new construction and a 1% increase in add-on replacement, partly offset by a HSD % decline in demand from commercial customers driven by weaker rehab & replacement markets. We provide the market breakouts for perspective in the charts and tables below.

Figure 155: HVACR Channel Share



Source: HARDI

Table 75: HVACR Channel Flows

In billions

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Wholesale distribution	\$29.5	\$29.6	\$29.4	\$30.5	\$31.3	\$35.5	\$38.0	\$42.2	\$41.7
Rest of channels	\$23.5	\$26.3	\$30.8	\$31.7	\$34.6	\$32.4	\$32.0	\$28.7	\$27.0
Total Contractor Demand	\$53.0	\$55.9	\$60.2	\$62.2	\$65.9	\$67.9	\$70.0	\$70.9	\$68.7
Wholesale distribution share of channel	56%	53%	49%	49%	47%	52%	54%	60%	61%

Source: HARDI

Table 76: HVACR Channel Demand By End Market

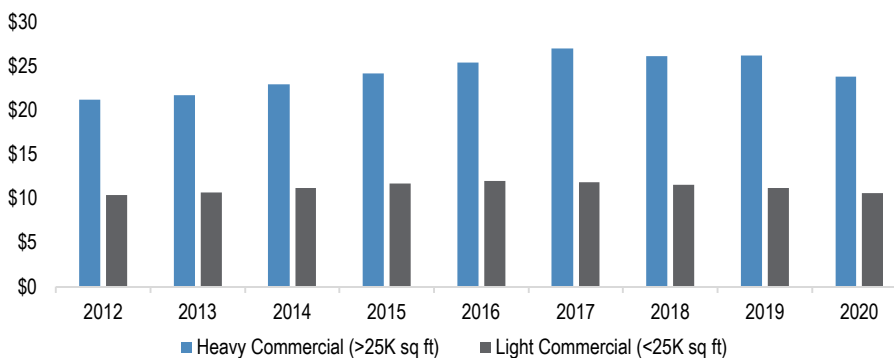
In billions

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Resi	21.4	23.6	26.2	26.3	28.6	29	32.5	33.6	34.4
AOR	18.5	20.1	22.4	22	23.8	24.2	27.4	28.4	28.7
New Construction	2.9	3.5	3.8	4.3	4.8	4.8	5.1	5.2	5.7
Commercial	31.7	32.4	34	35.9	37.4	38.9	37.5	37.3	34.4
Rehab & replace	26.3	26.8	27.7	28.6	29.4	31	30	29.9	27.4
New Construction	5.4	5.6	6.3	7.3	8	7.9	7.5	7.4	7.00
Total Contractor Demand	\$53.0	\$55.9	\$60.2	\$62.2	\$65.9	\$67.9	\$70.0	\$70.9	\$68.7

Source: HARDI

Figure 156: Commercial Demand By Sector

In billions



Source: HARDI

Survey Says... Product Availability Most Important to Contractors

HARDI, in conjunction with Farmington Consulting Group, conducted a national survey of HVAC contractors in September and October of 2020, providing some interesting insights into what they value most in their distributors and what they would like to see distributors invest more in, as well as their own performance through the pandemic and key trends they see coming away from it. The survey included 411 mostly small/mid-sized HVAC contractors geographically dispersed across the United States, primarily focused on the resi add-on/replacement market with all major brands represented. To start, the survey found that contractors see product availability / inventory levels as the most important attribute when selecting a distributor to purchase from. Pricing and timely/accurate delivery service round out the top three. As for value-added services that contractors would like to see distributors invest in, the #1 category is 24-hour emergency service, followed by delivery tracking and then marketing services for contractors. Mobile apps were surprisingly toward the bottom of the list here.

Table 77: What is Most Important to Contractors When Selecting a Distributor

Rank	Category
1	Product availability / inventory levels
2	Pricing
3	Delivery service (timely & accurate)
4	Equipment manufacturer brand represented
5	Local technical / field service support
6	Outside salesperson presence & relationship
7	Warranty
8	Counter / will call service
9	Training provided
10	Location
11	Credit terms / Flexibility
12	E-Commerce / Online ordering capabilities
13	Dealer Benefits / rewards program

Source: HARDI

Table 78: Value-Added Services that Contractors Want Distributors to Invest in

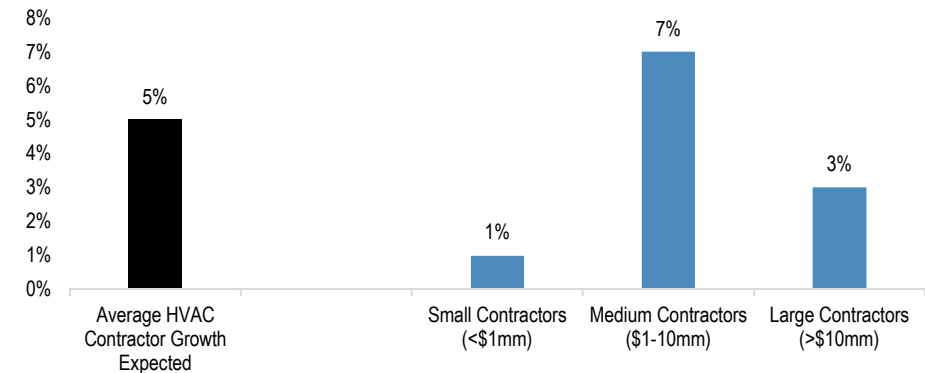
Rank	Category
1	24-hour emergency service
2	Delivery tracking system
3	Marketing services for contractors
4	VMI / consignment / auto stock replenish
5	Engineered drawings / layouts
6	Mobile App
7	Product locker pickups / overnight delivery to customer's lock boxes
8	Jobsite storage

Source: HARDI

Turning to financial recent performance and the outlook, the survey found that the financial impact of COVID-19 wasn't as bad as feared, with the average HVAC contractor's business flat during the height of the pandemic, with smaller contractors disproportionately impacted. Overall, the average HVAC contractor sees 5% revenue growth in 2020, with all regions growing LSD-MSD. While this is approximately half the rate of increase experienced in 2019, it's solid given the backdrop. The financial outlook for majority of HVAC contractors is positive, and for those that were negatively impacted, they believe their business will fully recover by the end of the 2021 selling season.

Figure 157: Expected 2020 HVAC Contractor Revenue Growth

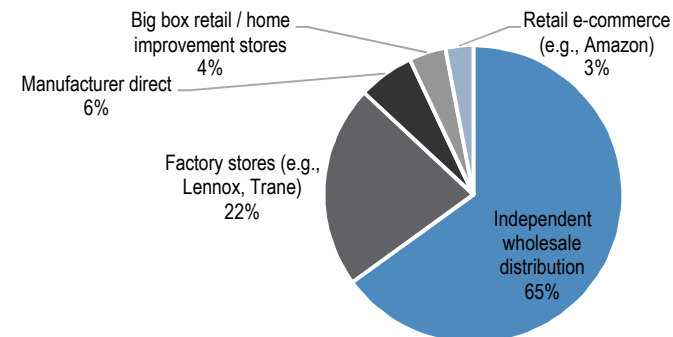
y/y % change



Source: HARDI

Lastly, on contractor views on distributors since COVID-19 and expectations post the pandemic, the overall consensus was that independent wholesale distribution remains the best avenue for them to obtain products, clearly outperforming every other channel in the eyes of HVAC contractors. Areas where distributors have fallen short in their view have been 1) lack of product availability / inventory, 2) lack of outside sales contact, 3) closing their doors to customers, and 4) understaffing. Of note, 26% of HVAC contractors said they are purchasing more from different distributors, and buying through alternate channels due to the impacts of COVID-19, primarily due to lack of product availability.

Figure 158: Alternative Channels For HVAC Contractors



Source: HARDI

Looking ahead they believe the crisis has accelerated the use of e-commerce, with 41% of HVAC contractors expecting growth in the amount of business they conduct online with distributors. Alternative pickup and delivery options are seen as here to stay, with 31% of HVAC contractors anticipating a decrease in how often they physically go into a distributor's counter, and 34% expecting an increase in their utilization of alternative delivery options. This said, there is still a strong desire for in-person outside sales visits, as 79% of HVAC contractors do not want to receive less in-person visits from a distributor's outside salesperson.

Table 79: HVAC Contractor Expectations Post-COVID-19

Increased business conducted online
Less in-person visits to distributor's counter
More use of alternative delivery options
Outside sales presence maintained

Source: HARDI

WSO scale an advantage vs. local competitors

WSO's market share has been built up over the past 20 years as the company has expanded from \$64mm in sales in 1989 to around \$5B today. In its core states (where it has its highest share currently), WSO is generally 2-4x larger than the next-largest independent or factory (OEM-owned) operator, giving it a significant scale advantage in terms of being able to service its dealer contractors. The benefits of scale highlighted by the company include rich product availability and dense branch network to provide service to customers, purchasing power from suppliers, greater share of wallet from customer spend, talent acquisition and retention, and technology investment scalable efficiently within branch network. On the first point, we note that product availability again ranked highest this year in terms of attributes that contractors and manufacturers value from wholesale distribution, as discussed above. This was particularly relevant in 2020 given COVID-19 impacts, with surprisingly strong demand over the summer juxtaposed against cautious inventory levels that made finding equipment a challenge. According to HARDI, product availability is key to guarding against so-called "Critical Selling Events" (tipping points in distributor/contractor relationships that may cause permanent loss of customer). HARDI research has shown that for a majority of contractors a reliable distributor is highly valued because they help guard against reputational risk. Contractor business is hard-won, and once earned it rarely shifts. However, if distributor reliability wanes, they're at risk of losing customers.

Table 80: Channel attributes most important to contractors when making purchases

Rank	2019	2020
1	Product availability	Product availability
2	Price	Price
3	Customer service	Delivery service

Source: HARDI

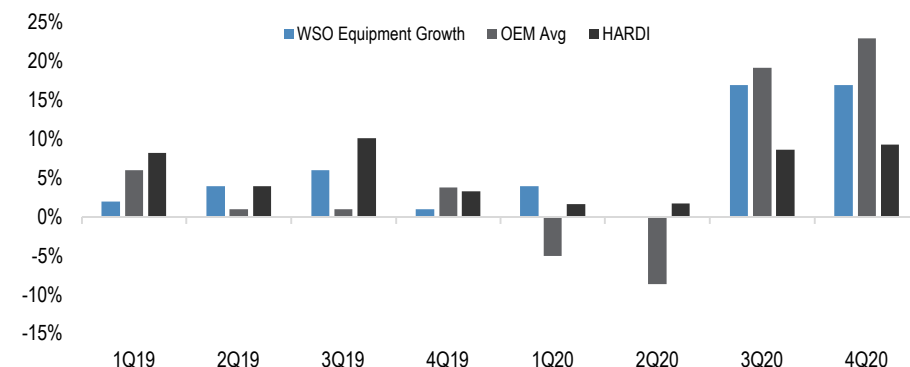
Table 81: Channel attributes most important to manufacturers

Rank	2019	2020
1	Product availability	Product availability
2	Price	Customer service
3	Customer service	Accurate and fast delivery

Source: HARDI

We believe WSO's relative growth outperformance in 2020 was in part a function of its strong product availability vs. peers, allowing it to win market share during the pandemic. As seen in the chart, WSO same store equipment growth vs. HARDI and HVAC OEM revenues picked up through the year vs. lagging performance in 2019.

Figure 159: WSO Equipment Sales vs HARDI and OEMs



Source: J.P. Morgan estimates, Company data.

Watsco was an aggressive acquirer last cycle . . .

Given the highly fragmented market for HVAC distribution, WSO has focused on a growth strategy (called “buy and build”) primarily based on aggressive acquisition into existing/new markets, supplemented with organic growth. Since 1989, the company has successfully completed the acquisition of >50 HVAC distribution businesses. In particular, a large number of acquisitions were completed from 2002 to 2007, resulting in robust new store sales growth during this period, with another pickup in activity occurring in 2019. This acquisitive strategy is similar to industrial distributors across a range of different sectors, and adds to the scale advantages already enjoyed by WSO.

Table 82: Key Acquisitions Since 2000 (Excluding Carrier Enterprises)

Period	Business	# of Locations	States Served
Nov-19	HVAC	7	New York, Connecticut
Apr-19	HVAC	7	New Jersey, New York, Connecticut
Apr-10	HVAC	2	Tennessee
Sept-09	HVAC/R	6	Utah
May-09	HVAC	95	US Sunbelt
Aug-07	HVAC	54	Florida, Texas, California, Georgia, Tennessee, Arizona, Colorado, Louisiana, Nevada, New Mexico
Jul-07	HVAC	1	Louisiana
Dec-06	HVAC	10	Nebraska, Missouri, Arkansas
Oct-06	Refrigeration	8	Tennessee, Mississippi, Arkansas
Mar-06	Refrigeration	2	Alabama
Feb-06	HVAC	1	Missouri
Jan-05	HVAC	27	North Carolina, South Carolina, Georgia, Virginia, Tennessee
Apr-04	Refrigeration	2	Texas
Apr-03	HVAC	52	Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, Texas, Virginia
Jan-02	HVAC	2	Arizona, Mississippi
2000	Refrigeration	1	Florida

Source: Company reports.

. . . and further distributor consolidation slow to develop, but Russell Sigler/DASCO potentially signals more to come

However, the pace of industry consolidation among independent distributors slowed in recent years prior to the company’s 2017 acquisition of a 35% interest in Russell Sigler (RSI). While WSO has acquired a large amount of revenues through its Carrier Enterprises JV, acquisitions of smaller, family-owned business have been limited. We think this is partially cyclical as family-owned distributors are unlikely to receive the same valuation they would have at the 2006-07 peak and therefore are reluctant to sell at the lower price. Conversations with WSO management reinforce this, with

management looking to do larger deals but content to wait out the market and grow internally until it begins to find willing sellers.

The company took its first major step in some time in 2017 by acquiring a 35% interest in Russell Sigler, a \$650mm US HVAC distributor focused on the Western region where Watsco has historically less exposure. The family ownership group owns the remainder of the company and Watsco hopes to acquire more over time, a solid move strategically to broaden its exposure and offer more contractors access to Watsco's data and analytics tools (discussed below) to drive future sales growth. In 2019, its Carrier Enterprises JV acquired Peirce-Phelps, a \$206mm HVAC distributor with 19 locations serving >9,000 customers for both resi and commercial use. Additionally, they acquired N&S Supply and DASCO that same year, smaller acquisitions to fill out their presence in the Northeast. The company has an essentially debt-free balance sheet and plenty of capital to deploy for further consolidation, but timing and willingness of sellers will continue to dictate the pace.

An OEM partnership on distribution could create additional opportunities

Outside of consolidating smaller players, the other opportunity for a large shift in the industry would be an OEM selling or partnering with an independent distributor on its company-owned branches. Much as we saw with the Carrier Enterprises deal, a large and sophisticated player could be seen as an attractive partner, particularly if the OEMs view the lower margin distribution as non-core. This would require a strategic shift, however, among the larger OEMs with company-owned distribution (i.e., Trane, Lennox, or Goodman). We don't see Lennox as a possibility given the investments they have made in distribution, and it would also surprise us if Trane and Goodman went down this path. York could be an option, as the company has stated they are subscale in resi distribution and looking to address this through M&A. We think JCI would rather buy another OEM, but a partnership with WSO is also in play. At ~5% share in residential, York would represent a smaller opportunity than Carrier at 25% share, but still substantial relative to acquiring small distribution competitors. Watsco noted at our recent J.P. Morgan conference that they don't sell any JCI products, and this is not on purpose; they have a half dozen decent sized distributors that they would love to be a part of the Watsco family, a natural entrance into that relationship as those products/brands are exclusive to those distributors today.

Watsco has aggressively expanded its technology initiatives in the past, though investments are now slowing down

Watsco seems at a crossroads on technology investments, with slowing SGA growth and rationalizing support resources as it leverages the new infrastructure. The company has hosted investor days for the past several years, detailing their significant investments in technology initiatives, which we think further solidifies its dominant position in a highly fragmented market. We think Watsco is now well ahead of other independent distributors on the technology front and is about even with OEMs like Lennox, who have invested heavily in their capabilities. Below, we summarize the company's initiatives. Broadly, they are looking to execute on 3 key themes, which play out in the discussions below: 1) Make it easier to do business with Watsco (contractor assist app and e-commerce); 2) Make Watsco more profitable and efficient (business intelligence and big data); 3) Enable new profit streams (WSO Ventures).

Recently however, WSO slowed on its previously heavy investments, looking to harvest them. While they remain fully committed to pursuing the digital evolution of their business model, our sense is that the seemingly "at all costs" approach of the

past few years is ending, with management now tasked with stabilizing cost creep to show 3% or less SG&A growth (normal inflation) versus the 3-4% historically and as much as 5+% in recent years. The key drivers are people, freight and lease expense, with technology allowing improved productivity across all these buckets, ranging from warehouse/inventory automation/visibility to reduced showroom space.

Contractor assist app: Watsco's contractor assist app allows contractors to complete jobs more efficiently by allowing them to examine bills of materials and product manuals, look up part availability, and make orders within the app, saving hours of time and multiple trips to and from the store. Last year, they talked once again about how they have streamlined the warranty process, with a mobile app for contractors to digitally look up and process warranties. In the past, it was difficult to tell if a product was under warranty and required examining lots of paperwork and consulting with the manufacturer and WSO techs. Now, they have interfaced directly with the manufacturers, and an installer just needs to enter the serial number of a part into the app to check if it is in warranty, providing immediate claim adjudication and saving several man hours. They can also look through the claim history on a product within the app to determine if there is a potential undiagnosed issue elsewhere in the system, while also eliminating cumbersome paper forms.

E-commerce platform: The company has also improved its e-commerce platform, making 120+ enhancements over the past year. Notably, they have gone from a 5-step checkout process to 1 step, facilitated express pickup, added a quick order option, and improved search functionality through a part finder tool. They have catalogued up to 30-40 attributes per product and uploaded them to the e-commerce database, which now has ~12mm pieces of information, 3x higher than last year. They have also seen an increase in usage, with 2x customers on-line y/y and they now have more on-line orders than standard orders. Last year, they also highlighted implementing a machine learning product search engine, as they possess an extensive database of 680K skews of information. Lastly, they are extending their distributor management inventory app to customers, and built an interface using AHRI data such that customers can look the AHRI number on a product and get all the product specs on it, make sure it's a good match and gather all the information to get city permits. Overall, the messaging here is about refining new technologies and increasing adoption.

Business intelligence: They have made efforts to capture and analyze more customer data to drive actionable insights, developing tools that analyze correlations across various data sources and identify opportunities. Last year, the company gave examples of applications to optimize inventory, digitizing product info management (PIM), and digitizing warehouse operations (order fulfillment). They have been developing programs to find new sales opportunities by identifying non-core customers with the most growth potential, and creating personalized URLs for them customized to their needs in order to win more of their business. Business intelligence is also being used to find opportunities to strategically raise prices in certain areas, though details were scarce on this front. They also talked to BI driving customer retention, as predictive attrition modeling allows them to focus more on at-risk customers, such that sales teams and management teams can view patterns that could indicate whether a customer may be seeking another partner, and which products are more likely to be purchased. They are also able to segment customers more effectively, and determine which areas they can most effectively upsell them. Importantly, the company focused on how adoption of business intelligence is allowing branch managers to improve performance. According to the company, branch managers who use BI more often perform 5x better than those who don't, and

sales people using it more perform 7x better. Adoption overall is increasing, with the number of reports requested per day doubling over the last few years. Last year, the company also highlighted the re-usability of these data analytics applications, such that they can apply them from e-com to mobile without having to re-write them.

Watsco Ventures: The company highlighted three investments at its in-house incubator last year, and we came away impressed by the strategic direction. These investments make sound strategic sense, and help bolster existing platforms, while positioning the company well for any disruption in the residential space. Note that there was no update on financial impact last year, other than to say Watsco Ventures hopes to contribute to earnings growth by generating new profit streams with new businesses. Last year, Watsco highlighted again its internally developed app called On Call Air, a proposal management system that optimizes the relationship between contractors and customers. The tool includes an easy proposal builder, providing the customer with more transparency and the contractor with less paperwork, in an industry where HVAC presents significant investments yet customers have almost no data or frame of reference. It also allows contractors to more easily upsell customers on higher value products, with videos and reviews highlighting the benefits of higher efficiency. Their model is a subscription as a service, and they are seeing quicker wins from the use of this tool, with average sale of ticket going up and consumers selecting higher efficiency products as well as accessories to complement those products. The company sees this platform as differentiator and competitive advantage for them in the marketplace. The company also highlighted its new Credit For Comfort, a multi-level financing platform for contractors. This application should help customers purchase HVAC systems on a multi-payment basis, as contractors are often called in for unplanned repairs, with the customers not always having enough savings available. This simplified, one-stop shop enables the contractor to check if the customer is eligible for prime rate, otherwise will automatically re-enroll them for alternative forms of financing, with further review later. With 3 out of 10 contractors selling with financing today, Watsco believes this platform will make it easier for the contractor to get an initial sale and get started on financing, and is seeing good traction so far. Next, they highlighted again their House Call, an app that links customers to small (1-10 trucks) contractors, in a subscription as a service model. A customer requests the contractor, who then connects to the customer via the app and can send them information, including time of arrival. The app works for several different types of contractors, but once the customer uses an HVAC contractor, they become that customer's HVAC contractor in the app, allowing small contractors to potentially improve customer stickiness. Another investment highlighted was Service Business Education, a contractor consulting business that works with contractors and provides them with a business training and coaching program to teach them how to accelerate growth through leveraging big data. Lastly is their investment in Sentries, an in-house application that was still patent-pending last year that monitors units' performance and analyzes trendlines to predict failures, such that they can notify contractors of urgent needs more immediately, and customers can feel assured that their units are being continually monitored.

Long-term industry technology landscape a TBD, but WSO well positioned:

Ultimately, we see technologies of this sort converging over the long-term, with potential eventually for more of an integrated technology solution that does all of the above: matches customers to contractors (House Call), manages the customer relationship and point of sale (On Call Air), and provides the contractor with the resources to effectively do the job (Contractor Assist). The question then becomes how this plays out, and there are certainly TBDs. Even though the HVAC industry has proven to be resilient to change/disruption, the same could be said for many industries before they were flipped on their head over the past decade. Could Uber link customers with contractors in trucks? Could Amazon catalogue HVAC systems, increasing transparency and potentially price competition? Competition from Amazon and other online distributors (e.g., SupplyHouse.com) could present a threat on commodity, low weight, high value products like furnace boards, thermostats, small pumps, and humidifiers, with websites providing increasingly content rich information, key to driving demand. Regardless of how this plays out, we think WSO is making smart investments for the long-term here and is positioned well.

An Update on the Connected Home

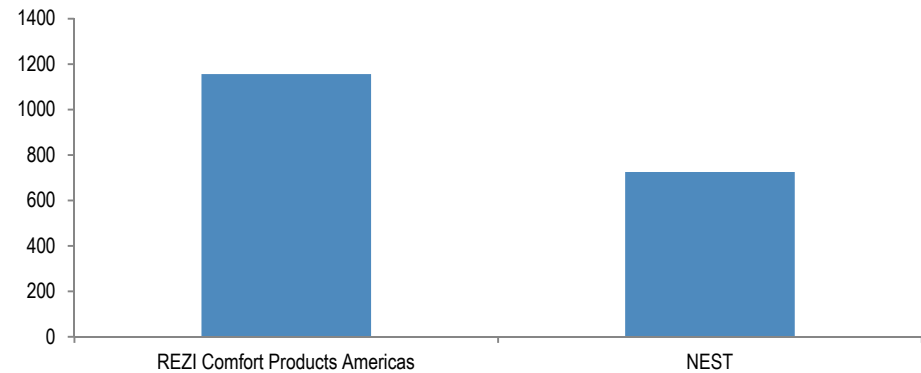
We take a brief look at recent developments in the connected home space in this section. Ultimately, while growth here is likely to be rapid over the coming years, it is still somewhat unclear which players will capture value and what form the technology will eventually take. On thermostats and the integrated home, we believe Honeywell's large installed base and early mover advantage with the Lyric positioned it well initially, but upstart players have moved into the space (for ex, Carrier's UltraSync smart home security solution) and competed effectively while HON has lagged somewhat, though it remains a key player. On HVAC, companies have also developed smart thermostats and diagnostic/prognostic capabilities that add significant value, though we ultimately view this as more of a product-specific offering that is unlikely to leverage across other residential platforms (lighting/security/etc.). However, while we think it is unlikely that an HVAC player ends up "owning" the connected home; the smart capabilities these companies are developing are valuable and should fit in well within a broader connected home ecosystem, discussed further below.

Thermostat market: Honeywell Home/Resideo a top player, but competition intensifying

Honeywell spun off its Home business in 2018, along with its ADI Global distribution business, into the stand-alone company Resideo. Resideo continues to sell smart home solutions, including thermostats, humidifiers, security systems, etc. under the "Honeywell Home" trademark through licensing of the name. Honeywell has been in the business for 100+ years, a key part of every technological evolution in this industry, with its smart thermostats installed in >150mm homes. REZI is a \$5B business, with products and solutions representing ~40% of sales. Resideo said that it installs ~15mm system and components per year and have over 6.7mm connected customers. The Products and Solutions segment serves 3 primary markets – firstly, Comfort, which focuses on thermostats, temperature control products, indoor air quality and water leak prevention solutions, with annual revenue of \$1.1B in 2019. Secondly, the Residential Thermal Solutions with \$600mm of revenues, focused on boiler systems, water heater controls and furnace systems. The Pro Security business with ~\$800mm of revenues, focused on pro security panels, peripherals and software. HON Building Management Solutions announced wireless thermostats as a part of its innovation pipeline of 25+ new product launches, with single-click installation, location aware technology and lower total cost of ownership. Players in this space include Nest, EMR, LII, Carrier, Trane, JCI's GLAS, Hive, Ecobee Nortek among others. For a frame of reference, Nest is likely the second largest player on smart thermostats, quickly catching up with revenues of ~\$700mm. This business was a separate company under the Alphabet umbrella, and was re-acquired by Google in 1Q18.

Figure 160: REZI vs Nest

\$ in millions



Source: J.P. Morgan estimates

REZI revenues declined 17% in the most recent quarter, with Products & Solutions decreasing 26% y/y, due to a decline in demand early in the quarter and COVID-19 related factory and supply chain factors. REZI said that business activity and orders troughed in April and improved sequentially further each month. They saw a strong month in July, driven by end-user demand rather than channel destocking. Resideo had 5% organic growth in 2019 with 2% growth in Products & Solutions, but has withdrawn FY20 guidance citing pertinent business risks

“Smart thermostat” competitors have narrowed the competitive gap

According to Navigant, demand for smart thermostats has exploded over the past few years due to heightened awareness from new devices. Navigant recently noted that smart thermostats have become a staple in many connected home solutions and are starting to reach a broader segment of consumers, including low income housing, newly constructed homes, multifamily dwellings, and small-to-medium businesses (SMBs). These devices also enable companies to better engage their customers and reduce churn, explore new service-based business models, and participate in grid flexibility programs. Since 2016, advanced thermostats have continued to see steady uptake, now reaching higher levels of market maturity. Additionally, we see the most recent versions of smart thermostats featuring voice-enabled solutions and compatible with platforms such as Amazon’s Alexa and Google’s Siri. New devices have disrupted the status quo by going direct to consumers, attracting both early adopters and mainstream customers, and smart thermostats are now starting to make their way as a staple in home solutions and into new customer segments, as consumers and vendors become increasingly aware of benefits, and utilities move from demo pilots to full programs. In 2019, Navigant cited a more mature and consolidated smart thermostat market, with leading players gaining more traction and smaller players being acquired or falling by the wayside in terms of brand recognition.

Navigant research ranks smart thermostat companies based on Strategy and Execution. They use the following criteria to compare manufacturers: Vision, Go-to-market strategy, Integrations, Technology, Geographic Reach, Sales and Marketing, Product Features, Product Portfolio, Pricing and Staying power. They evaluate 12 smart thermostat manufacturers that are recognized in the market by established brand name, innovative offerings, and success in selling thermostat solutions.

Honeywell has traditionally been the #1 player, followed by Nest, but in 2016, the leaderboard had HON in 3rd place, with Ecobee taking over the #1 spot and Nest staying at #2, and with some smaller players (WeatherBug, tado, Quby) emerging at the expense of some larger traditional players (Emerson, Carrier). REZI cited key players in the Connected Thermostats space, including Nest, Ecobee, tado, Hive, EMR, and JCI's GLAS. Navigant's latest report, published in 2019, named Google Nest as the #1 player, followed by Ecobee and REZI in the 3rd place.

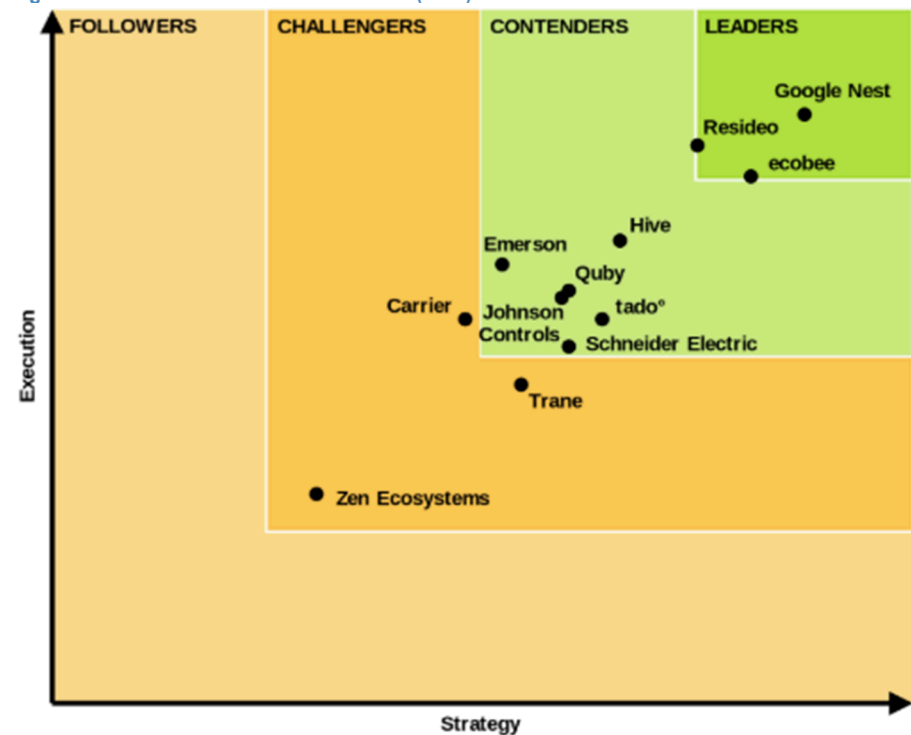
Table 83: Top 10 Smart Thermostat Vendors

Rank	2015	2016	2019
1	Honeywell	Ecobee	Nest
2	Nest	Nest	Ecobee
3	EnergyHub	Honeywell	Resideo
4	EcoFactor	EnergyHub	Hive
5	Schneider	EcoFactor	tado
6	Ecobee	Schneider	Quby
7	Emerson	WeatherBug	JCI
8	Comverge	Tado	Emerson
9	Carrier	Quby	Schneider
10	Energate	Energate	Carrier

Source: Navigant Research

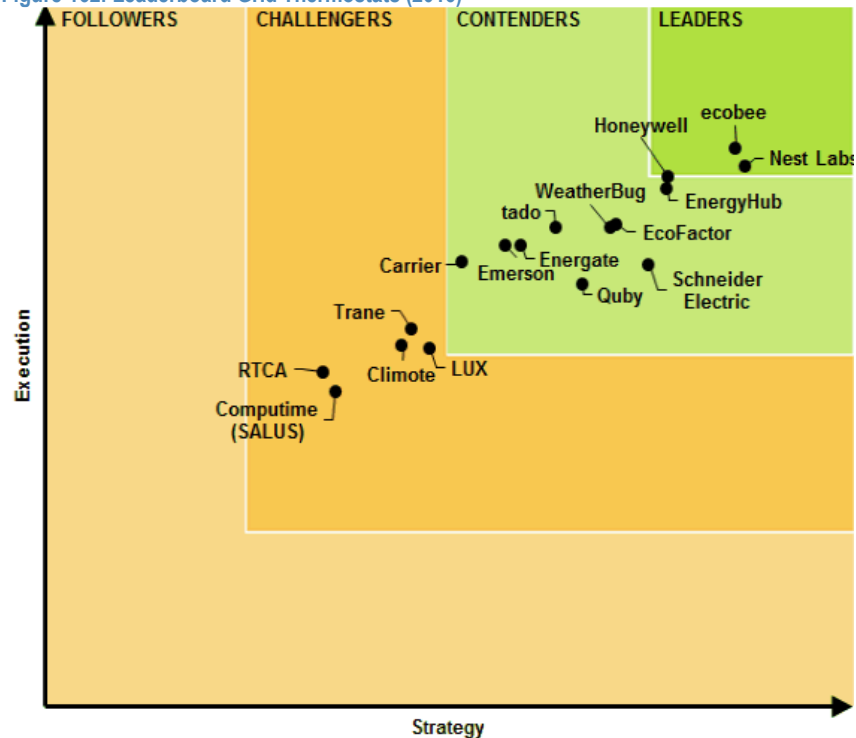
Navigant Research also publishes a smart thermostat Industry Leader board that rates key players along two dimensions: strategy and execution. They then divide up the competitors into four categories: followers, challengers, contenders, and leaders. Nest leads on both strategy and execution, followed by ecobee and Resideo. These top 3 make up the "Leaders" category, while a range of players like Hive, Emerson, Quby, tado, Schneider Electric and JCI make up the "Contenders" category. Carrier, Trane and Zen Ecosystems are listed a bit further down as a "Challenger."

Figure 161: Leaderboard Grid Thermostats (2019)



Source: Navigant

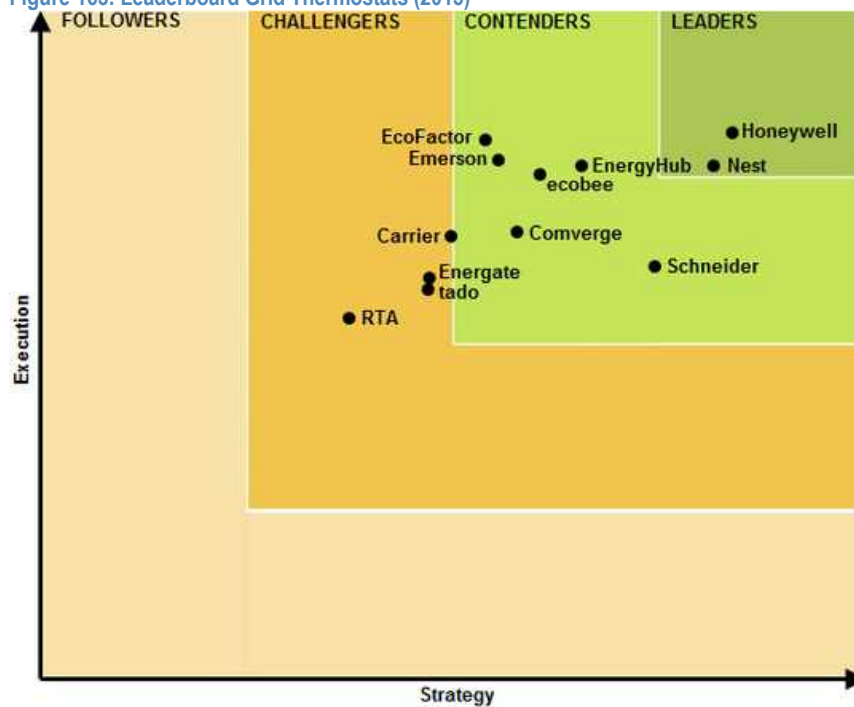
Figure 162: Leaderboard Grid Thermostats (2016)



Source: Navigant

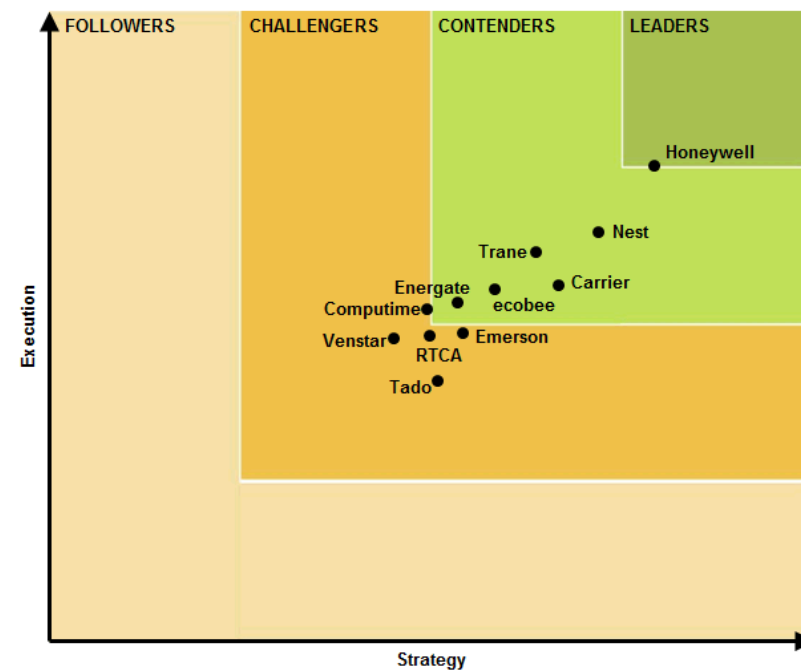
Our overall take is that while the market remains crowded at the bottom and technology will continue to evolve, the top players remain relatively stable for now, with year-to-year swings in the leaders based on technology, but installed base does matter and HON/REZI remains well positioned, though it has been overtaken by Google Nest and ecobee. However, we do acknowledge that the gap between Honeywell and competitors has narrowed significantly since 2013, as shown in the previous leaderboards below and with larger players entering/focusing on this space (NEST is now a Google-managed, and a much larger business than before). REZI's products still stack up well on functionality but haven't quite improved to the same degree as competitors have, in our view. We have also heard through channel work that compatibility with the latest smart home technology like Apple Homekit and Amazon Echo had been running behind at HON. Additionally, our channel checks showed that HON had a gap in the DIY market, which the company has aggressively invested to fill with new products, and the spun-off REZI cited DIY as an important channel for them to expand their presence in.

Figure 163: Leaderboard Grid Thermostats (2015)



Source: Navigant

Figure 164: Leaderboard Grid Thermostats (2013)



Source: Navigant

There are also some other noteworthy competitive shifts from 2013 to 2016 for companies within our EE/MI coverage universe. Carrier appears to have slid over the years as it now rates lower along the strategy dimension (not surprising given less focus on residential). Emerson has moved from “challenger” to “contender,” primarily on a dramatic improvement in execution and no doubt a product of the company’s push to improve the Sensi thermostat, for which, we think, they’ve made even more strides over the past year. Trane, meanwhile, has moved from a “contender” to off the board in 2015 and to “challenger” in 2016, emphasizing the year-to-year swings that can occur in the methodology here.

Wide range of market estimates for smart thermostats, but all point to significant growth

There are no consistent data available on the actual size of the smart thermostat market currently, and growth forecasts vary across different third parties. iMarc Research expects the smart thermostat market to reach \$4B by 2024 at a 21% CAGR while according to Allied Research, the market is estimated to reach \$8.78B globally by 2026 at a 26% CAGR. However, REZI did cite a \$1.5B addressable market for its Connected Thermostats offerings growing MSD in 2019, but most forecasts have been withdrawn now due to business uncertainties. This can be likened to some extent to other technology-based products like smartphones or tablets that rode broad macro trends and moved from niche products to more mass-appeal products, applying innovation and a strong marketing push. ADT comprises less than 5% of Resideo’s revenue over the past 12 months and constitutes a multi-year relationship. ADT reported a resilient performance in the recent quarter, which they attributed to sustained demand for consumers’ basic needs for safety and security, combined with trends of emerging de-urbanization. They cited a large and growing market for security with ~120mm single-family homes in the US with a penetration rate of ~20%. Although there has been heightened awareness regarding security needs, ADT cited slower commercial demand after experiencing low double-digit organic growth in FY19 and early 2020 in commercial revenue. ADT expects smart homes to grow at 20% CAGR between 2018 and 2023.

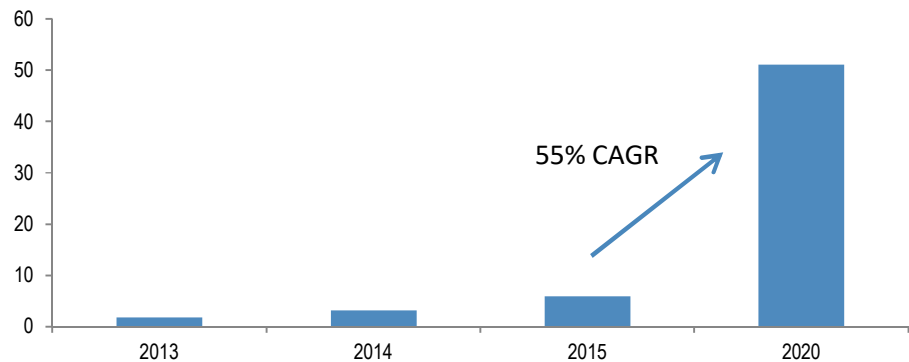
According to Bekryl, worldwide smart thermostat market sales is estimated to be valued at US\$ 1.7 billion in 2019, driven by growing demand for home automation, increasing consumer spending on connected devices across developed countries such as US, and the UK. In addition, growing investment in telecommunication infrastructure especially in context to 5G technologies is anticipated to drive growth of the market in the near future. In 2019, the residential segment accounted for the largest revenue share of over 80%. The North America smart thermostat market currently dominates the global market and is estimated to account for over 70% revenue share in 2019. This is primarily due to the presence of robust centralized HVAC infrastructure and high internet penetration. Above 75% of the homes in the US run on central-based HVAC systems. Western Europe is expected to register significant revenue growth rate during the forecast period. However, other countries are expected to register a moderate growth rate in the coming years. Industry players are focusing on new products with support for Alexa, Google Home, etc. in order to increase ease and convenience for users, and also to broaden their product portfolio. In addition, key players are focusing on air-based smart thermostat in other emerging countries in order to gain higher market share.

According to Berg Insight via ACHR, the smart thermostat market grew by 81% in 2015 to 5.8mm units, with North America representing 4.5mm (78% growth). In 2018, the smart thermostat market grew to 18.9mm units in North America and

6.6mm units in Europe in 2018. They forecast that Europe and North America will grow at a 20% CAGR in 2018-2023.

Figure 165: Smart Thermostat Market

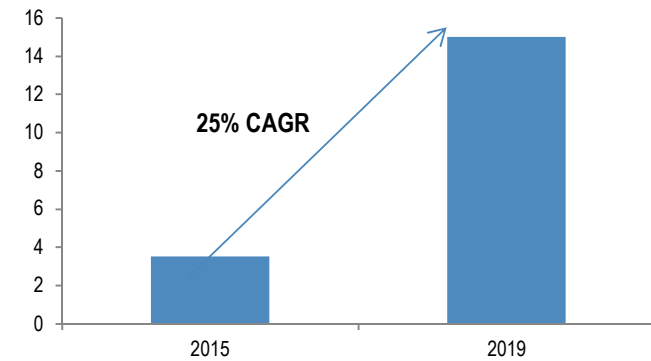
Units in millions



Source: ACHR

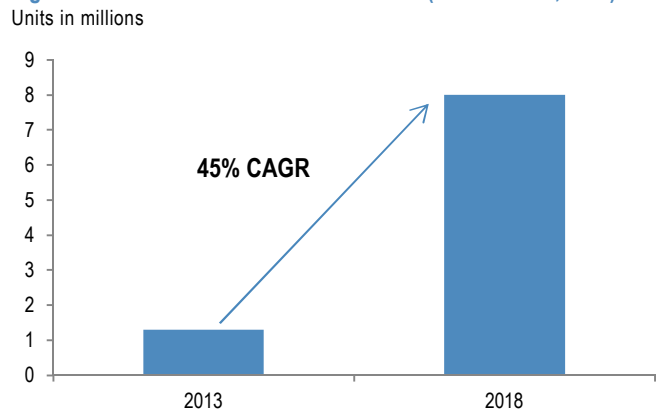
Other forecasts and market sizing from other firms in prior years are a bit less aggressive but still show strong growth. IHS pegged the 2015 market at ~3.5 mm units and expects a more modest 25% CAGR through 2019 with penetration moving from 21% to 30% of new thermostats. Additionally, ABI research from 2014 stated that the global smart thermostat market can grow from ~1.3 mm units in 2013 to 8 mm units in 2018 (~\$600 mm). In 2018, they stated that they expect global install base of 300mm smart homes by 2022, with over 80mm homes having smart thermostats, which would imply 80% CAGR if there were in fact 8mm units in 2018. ABI Research finds that worldwide by 2022, more than 80 million homes with smart thermostats are set to have control of the heating and cooling in the home linked to smart grid control.

Figure 166: Smart Thermostat Unit Forecast (IHS)



Source: IHS

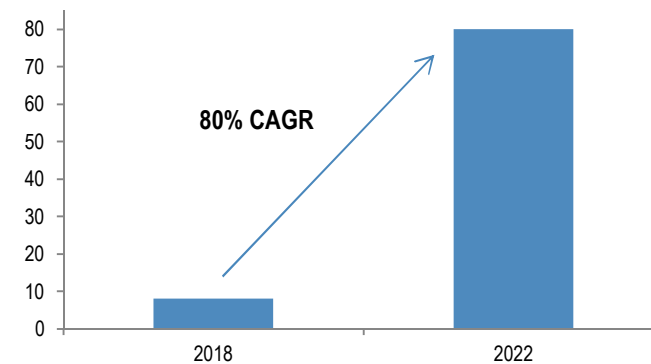
Figure 167: Smart Thermostat Unit Forecast (ABI research, 2014)



Source: ABI

Figure 168: Smart Thermostat Unit Forecast (ABI Research, 2019)

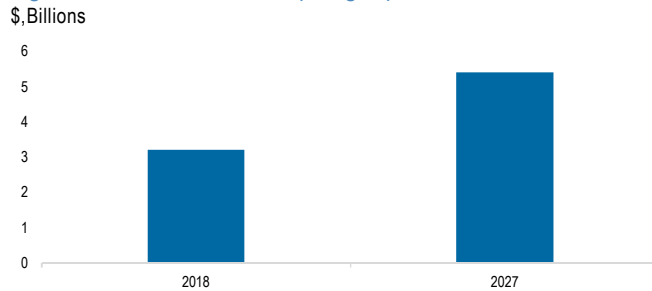
Units in millions, CAGR on 2018 base estimated in 2014



Source: ABI

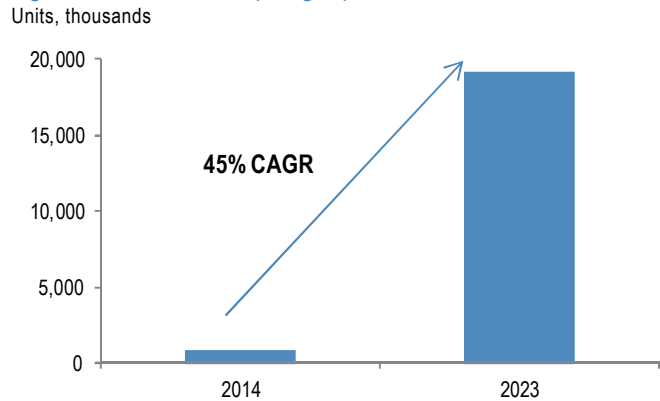
Navigant has pegged smart thermostat market revenue at around \$3.2B in 2018 (from \$1.1B in 2016), and they see growth to \$5.4B by 2027, adding ~\$2B to the market at an over 10% CAGR. They see ~\$1.9B of revenue in North America alone by 2027. Additionally, Navigant's report from the year prior called for a long-term market of \$2.3B by 2023. Unit-wise, it anticipates the market growing from 926,000 units annually in 2014 to 19.2mm by 2023.

Figure 169: Revenue Forecast (Navigant)



Source: Navigant

Figure 170: Unit Forecast (Navigant)



Source: Navigant

Other smart thermostats

Emerson Sensi—Emerson has expanded its presence in the market here, investing significantly in its Sensi product. The Sensi Wi-Fi thermostat was originally introduced in 2014 and has been iterated since, with the company introducing a premium version with a touchscreen, modern design with color, and proximity sensing. The product retails for ~\$170 across most channels. In terms of functionality, the product offers remote functioning, smart alerts for extreme temperatures or humidity, automatic upgrades, geofencing, and flexible scheduling with an easy DIY installation. The functionality is impressive and we think can compete effectively with the top of the line brands already mentioned, and Emerson sees the product well positioned in the industry, winning several recognitions. The company cited good growth here, not only through pro channel but also through big box retail and online sales.

Figure 171: Emerson Sensi Touch Smart Thermostat



Source: Company reports

Emerson has also built out its diagnostic and monitoring capabilities, originally under the “ComfortGuard” brand (on which we heard feedback of strong technology but expensive for the consumer market), but now under Sensi Comfort monitoring installations providing real-time system checks on how efficiently a system is running. According to the company, 40% of new installations are installed incorrectly, 70% of resi HVAC systems are performing below manufacturers’ specs, and 49% of energy bills are related to heating and cooling. They also have automated software to ensure that installations have been done properly, and are targeting big box channels like Home Depot as a key opportunity, ensuring that installations are done properly by contractors and selling a 24/7 monitoring service as part of a basic service agreement to the customer. The Sensi Multi-Thermostat manager was introduced last year in the light commercial building space, and the company is seeing good growth here. On Sensi Predict, they are working on commercializing house monitoring as an alternate to general service visits for its 130mm installed base in the US. This product introduced a couple years ago has seen good adoption in homes and is being rolled out to home improvement contractors, packaged as a maintenance contract that homeowners buy from contractors.

Figure 172: Emerson Sensi Comfort Initiative

Sensi Multiple Thermostat Manager Portal



-  **Centralized Monitoring & Control**
multi thermostat dashboard
-  **Smart Schedule**
scheduling special events
-  **Multi User Controls**
with administrator functionality
-  **Solution Cost**
Sensi Thermostat + \$1/month/thermostat

Launched in November

158

Source: Emerson

Trane Comfort LinkII—The ComfortlinkII is the most advanced Wi-Fi Thermostat offering by Trane. It comes with a large 7-inch screen, and the biggest differentiator versus competitors is the Nexia control platform, a proprietary platform that allows users to remotely manage home security, lights, and climate control.

Figure 173: Trane ComfortLinkII



Source: Trane

York GLAS—The GLAS is a smart thermostat for resi/commercial applications that is the first of its kind to use a translucent OLED touchscreen display, and users can touch the screen to change temperature, monitor indoor and outdoor air quality, and track energy savings. The control system is built on Microsoft technology, with a Windows IoT core and uses Microsoft Azure. GLAS can also be controlled by mobile app or voice, as it utilizes Microsoft's Cortana digital assistant. They have carbon dioxide sensing, VOC sensors, and can change fan speed to increase ventilation. When connected to the internet, GLAS also monitors tree, grass, and ragweed pollen count, UV index, and air quality index, helping allergy sufferers monitor the environment. They will be selling the product through their own channels as well as MSFT stores, and it is priced at \$249 (vs \$319 last year), more in line with the market.

Figure 174: York GLAS Thermostat



Source: JCI

Lennox iComfort—The device has cloud connectivity, so it can be accessed from anywhere a user has Internet access. The device also tests itself and offers real-time maintenance alerts for the user and the dealer. As data are continuously fed into the cloud from the HVAC unit, they can identify when a unit is not running at full efficiency and is likely to experience a catastrophic failure soon. This allows dealers to arrive to a job site before a unit actually breaks and provide low cost maintenance before the failure occurs. While there may be some concern of cannibalization (HVAC units lasting longer can trim replacement demand), Lennox notes that this changes the dynamic of the repair/replace discussion with customers by making it more of a push than pull dynamic and strengthening the customer relationships in the channel. Unique features include the one-touch vacation feature that overrides the thermostat programming while the user is away from home. However, this product has four wires compared with three wires in the latest competitor thermostats. Like Trane Comfort LinkII, this thermostat has the capability to send alerts and emails about system operation and diagnostics to the homeowner and/or the dealer that installed. Lennox has said that they find it tough to imagine an HVAC OEM ultimately owning the space for the connected home, but believe their iComfort system is as good as anything in the industry and their diagnostic/prognostic capabilities can ultimately feed into other systems. Most online links showed a price tag of >\$200 for the device, though price directly from the contractor may vary.

Figure 175: Lennox iComfort



Source: Lennox

Figure 176: Lennox iComfort S30



Source: Lennox

Lennox has also integrated its diagnostics capabilities with e-commerce through the DaveNet dealer portal, which is capable of real-time ordering, warranty and parts look-up, and on-site repair assistance and training. It is also utilizing the DaveNet portal to drive business to PartsPlus stores as contractors can view diagnostics data on DaveNet and swing by a PartsPlus location on the way to a job site to pick up everything they need in advance, rather than making multiple trips back and forth. These initiatives have been key in converting dealers and driving share.

Figure 177: DaveNet Portal Improves Direct to Dealer Capabilities

LII Dealer Support is a Differentiator



Source: Lennox

Commercial HVAC Outlook

This section provides our overview of commercial HVAC fundamentals as well as our model for the US market, the biggest driver of commercial revenues for players like CARR, LII, JCI, and TT. New construction is a larger part of the industry here (~30%), but this is also a significant replacement market, and increasingly services and solutions are becoming important aspects of the market. Unlike residential, commercial does not experience the volatility around efficiency regulations and channel inventory levels as it is more of a professional B2B sales environment. Sales cycles here are long term in nature, generated from big ticket bids that can be in the hundreds of thousands of dollars. The key drivers are the age of the installed base, with equipment useful life in the ~25 year range, many times extended by servicing, while more recently due to COVID-19 IAQ concerns, and ESG related drivers, customer awareness has been raised about the level of operational capability of these systems, potentially a catalyst for system replacement demand. However, customers are unlikely to make this large of an investment when cash flows are depressed due to industry/macro real estate fundamentals, so the cycle remains an important driver of activity. Below, we start with an outlook for the US construction market.

Commercial Construction Market Facing Near-Term Headwinds

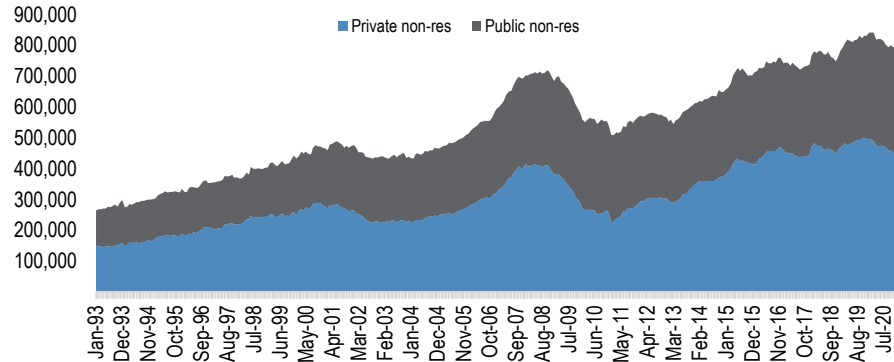
Non-residential construction, particularly private spending in retail, office, and institutional verticals, is a key driver of commercial HVAC demand and the starting point of the macro outlook. Spending is heavily influenced by financial market behavior, with activity that lags that of the general economy and fundamentals that are ultimately tied to job growth. Looking back over this cycle, the recovery in commercial construction generally took longer than expected, with some false starts in the indicators over the course of 2011-13 but momentum then began to build in 2014 and into 2015 and most of 2016, with 2017-19 still solid but no longer accelerating. We think the current pandemic is hitting commercial outlook significantly harder than resi, with declines in restaurants, hospitality, and office space while data centers and warehousing help offset these declines. Overall, we believe Commercial HVAC declines were in the LDD range for 2020, and we see LSD/MSD growth in 2021 driven by a rebound in replacement activity.

From an HVAC perspective, it's important to focus on *building*-related spend

To begin, it's important to refine the definition of "non-residential construction" as reported by the US Census on a monthly basis, as not all is directly relevant to the commercial building verticals traditionally served by EE/MI suppliers (largely related to electrical, security, and HVAC). Indeed, the total non-res number includes less relevant categories such as highway/street construction, power, transportation, and sewage & waste disposal.

Figure 178: US Non-Residential Construction – US Census Data

\$ millions, annualized rate



Source: US Census

Table 84: Categories (Shaded) Included in EE/MI Non-Res Index

2020, SAAR, \$mm

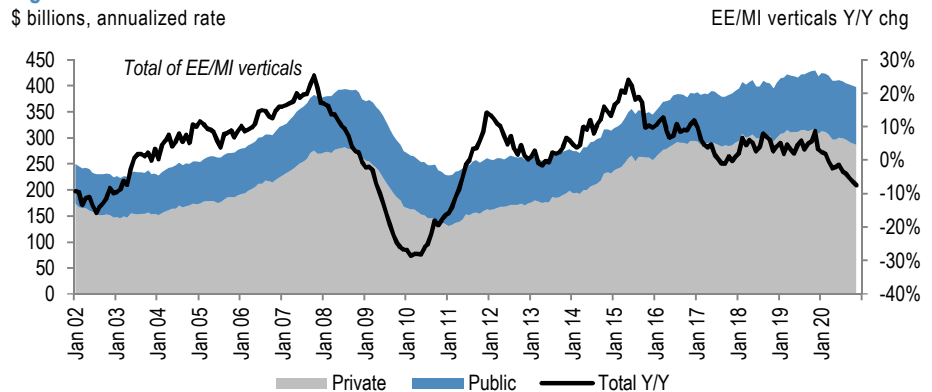
Category	\$mm	Description
Total Nonresidential	815,019	
Lodging	28,402	Hotels, motels, resort lodging
Office	81,195	Administration buildings, office/professional buildings
Commercial	83,720	Retail, supermarkets, restaurants, mini-storage
Health care	47,360	Hospitals, clinics, labs, nursing homes
Educational	104,760	All public/private education, libraries, museums
Religious	3,155	Churches, chapels, mosques, synagogues, and temples
Public safety	14,918	Police/fire stations, prisons, armories/military structures
Amusement & recreation	26,934	Stadiums, athletic clubs, movie theaters, meeting centers
Transportation	56,843	Airports, runways, rail facilities, sea freight terminals
Communication	22,648	Telephone, television, and radio, distribution structures
Power	119,351	Generation, T&D, oil and gas storage and distribution
Highway and street	100,255	Pavement, traffic lights, tunnels, bridges, retaining walls
Sewage & waste disposal	26,545	Sewage treatment/disposal plants, drains, pump centers
Water supply	18,468	Water treatment and filtration centers, reservoirs, tanks
Conservation/development	8,482	Dams, levees, docks, sea walls, bulkheads, tide gates
Manufacturing	71,985	Any manufacturing facility including chemical/refineries

Source: US Census

To better reflect exposures for non-residential construction suppliers in the EE/MI sector, we take the US Census put-in-place data and narrow it down to verticals that are primarily commercial buildings. We include office, commercial, manufacturing, lodging, education, and healthcare. We exclude categories such as power, highway & street, and sewage & waste disposal given these are less relevant for building suppliers.

Figure 179: EE/MI Non-Res Index

\$ billions, annualized rate

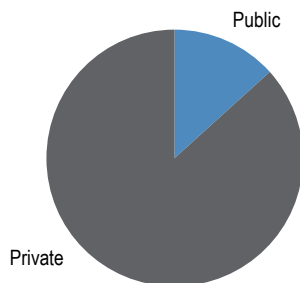


Source: US Census.

Public versus private, an important distinction

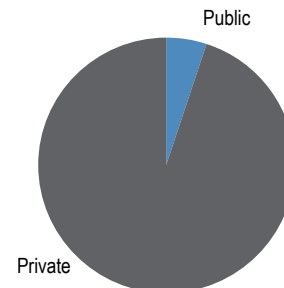
Moving beyond just the verticals, there is an important distinction between public and private spending that should remain a factor over the intermediate term. To start, Public is ~25-30% of the EE/MI non-res index, 75% of which is Education.

Figure 180: Office Spending – Public Versus Private



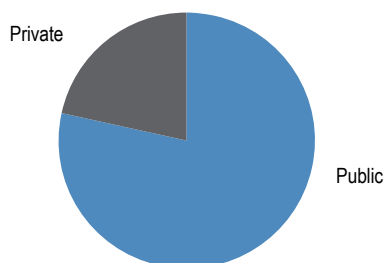
Source: US Census

Figure 181: Commercial Spending – Public Versus Private



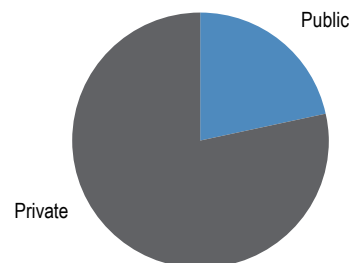
Source: US Census

Figure 182: Education Spending – Public Versus Private



Source: US Census

Figure 183: Healthcare Spending – Public Versus Private

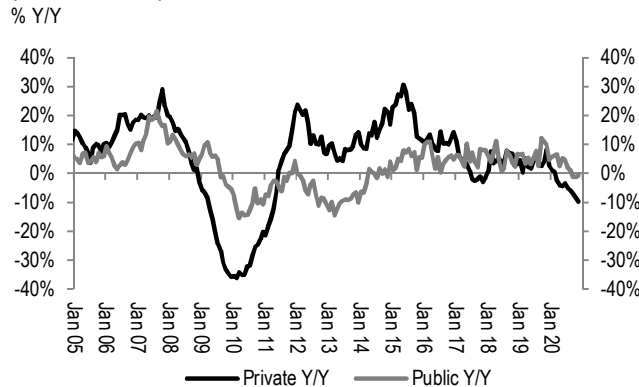


Source: US Census

Trends have diverged in recent years as public held up better during the downturn but also took longer to recover, and lagged private during the early to middle parts of the cycle, though trends have since reversed and public is now outperforming private.

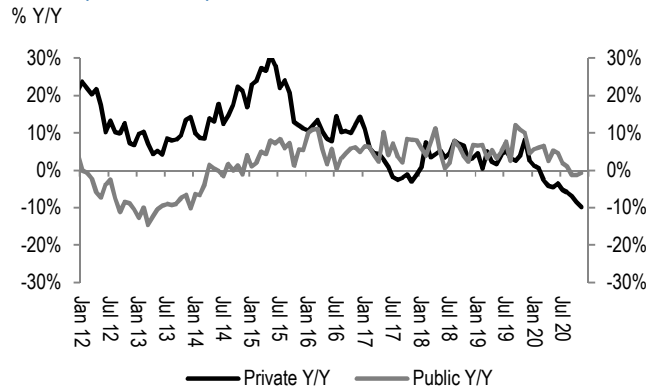
Overall, we expect continued pressure on spending across non-res building verticals for 2021.

Figure 184: Public EE/MI Index V Private EE/MI Index
(Historical View)



Source: US Census

Figure 185: EE/MI Construction Put-in-Place Index—Public vs. Private (Recent View)

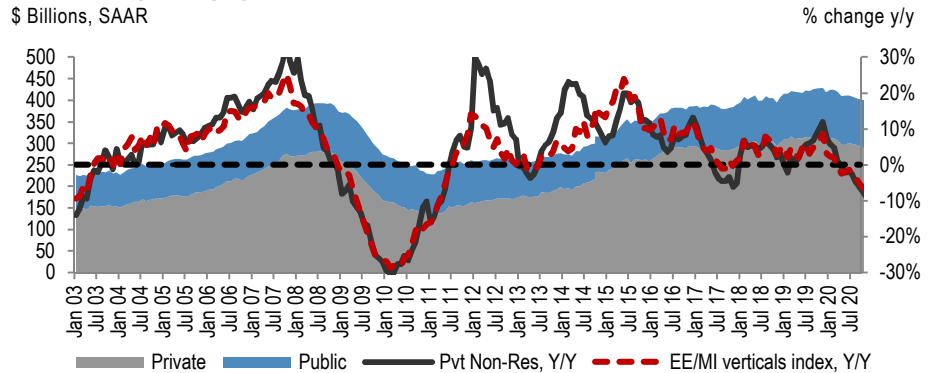


Source: U.S. Census.

When we combine public and private spending, the overall growth rate for the EE/MI non-res index is currently about in line with what would be suggested by simply looking at the overall private non-res monthly number, a commonly watched metric. Specifically, our EE/MI non-res index was down ~7.5% in Nov (-6.5% in Oct, ~-4.3% in 3Q20, ~-1.9% in 2Q20, ~+1.3% in 1Q20), with public markets (down 0.7% in Nov, down 1.3% in Oct) outpacing private markets (-10% in Nov, -8% in Oct). Among non-institutional verticals, office showed continued weakness, down 6% in Nov, vs down 8% in Oct, down ~8% in 3Q20, down ~3% in 2Q20 and up ~1% in 1Q20. Commercial was flat through Nov, vs ~+4% in 3Q20, ~+6% in 2Q20 and ~+6% in 1Q20 after picking up from HSD declines in 2019 and decelerating from MSD levels in 2H18. Among institutional verticals, Education was -4% in Nov (vs -5% in Oct, ~-3% in 3Q20, down ~1% in 2Q20 and up ~+3% in 1Q20), while Healthcare decelerated to down 1% in Nov, vs up 1% in Oct, ~+5% in 3Q20, ~+6% in 2Q20 and ~+7% in 1Q20. Manufacturing showed further declines with Nov down 15%, vs down 12% in Oct, -11% in 3Q20, down ~8% in 2Q20, down ~5% in 1Q20 and double-digit growth in 2019. The total non-res index including all verticals like Power, Highway & Street and Transportation, was down ~5% in Nov vs -3% in Oct, ~-2% in 3Q20, ~+1% in 2Q20, and ~+6% in 1Q20.

Figure 186: US Non-Res Construction for Office, Commercial, Healthcare, Education, Manufacturing & Lodging

\$ Billions, SAAR

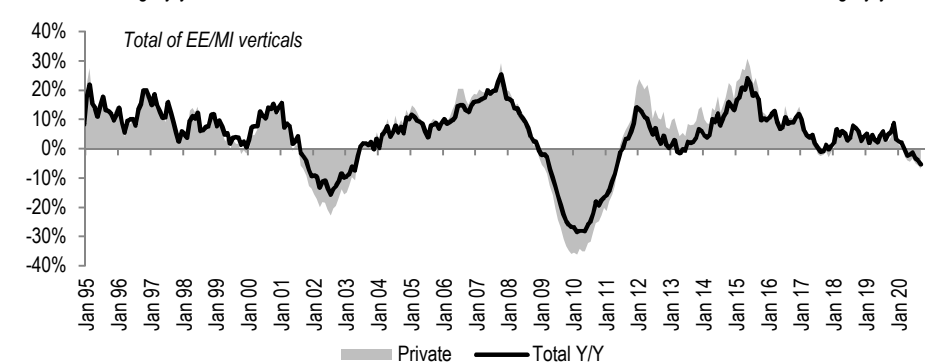


Source: US Census, J.P. Morgan

Figure 187: US Non-Res Construction - Total EE/MI vs Private EE/MI

Private % change y/y

Total % change y/y



Source: US Census, J.P. Morgan

Non-res macro backdrop decelerating

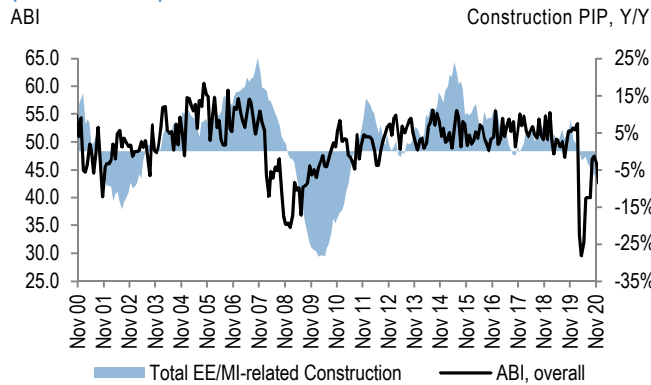
Weak non-residential construction markets contributed to the LDD declines in the Commercial HVAC market in 2020, while we see continued pressure for applied equipment in 2021, offset by a growth rebound in light commercial markets. This compares to sustained LSD growth in the commercial HVAC market expected prior to the pandemic. US non-res showed consistent LSD-MSD growth in 2018-2019, with put-in-place construction spend trending at LSD growth after a slowdown in 2017, and EE/MI non-res exposed segments generally grew in the LSD-MSD range. We take a brief look at a few of the key indicators below.

Architecture Billings Index (ABI)

The ABI is a survey of architects (>50 indicates growth) and has historically been a good directional indicator of overall construction activity, typically leading by 6-12 months. Over shorter periods of time, however, the index can often be volatile and not necessarily predictive of real activity levels. We look at both the overall ABI (which includes all verticals, including multi-family and mixed use) and the vertical-specific indices such as commercial & industrial (C&I) and institutional. Keep in mind that the sub-indices are reported on a three-month rolling average given smaller sample sizes. The ABI remained solid in the 50-55 range in 2019, marking 2 years of remaining around 50 or above, and the trend continued in early 2020; however, this

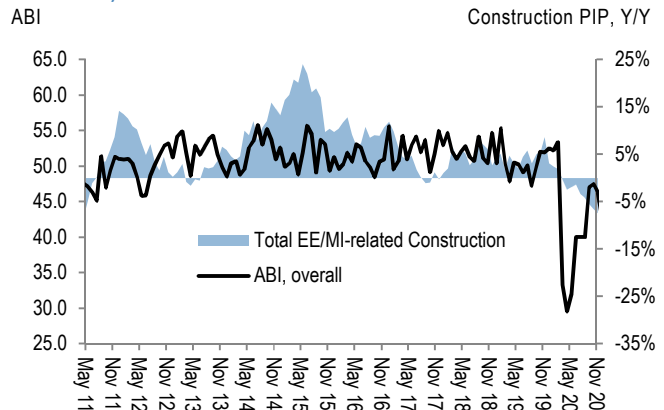
came to an abrupt halt in March when the index plummeted to 33 and then bottoming at 29.5 in April, holding in the 40 range through the summer, before a move up to 47.5 in October, and more recently back down to 42.6 in December. The metrics seen in March-May were even worse than the ABI levels seen during the GFC.

Figure 188: EE/MI Non-Residential Construction Index vs. ABI (Historical View)



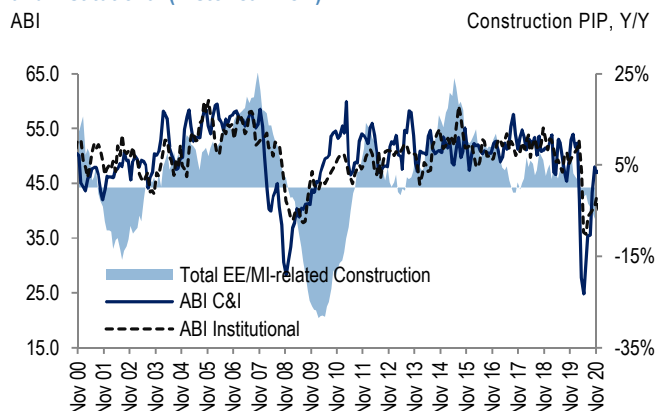
Source: AIA, U.S. Census.

Figure 189: EE/MI Non-Residential Construction Index vs. ABI (Near-Term View)



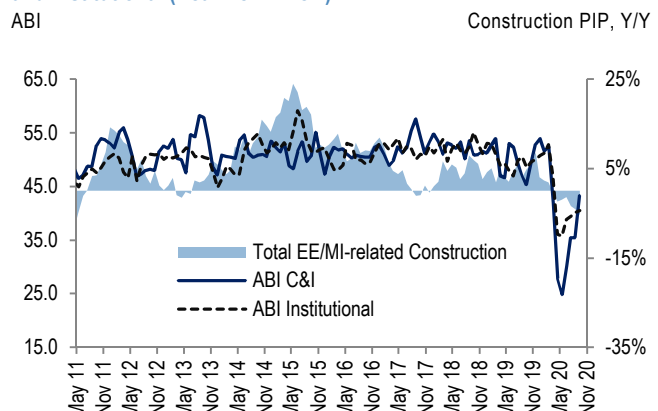
Source: AIA, U.S. Census.

Figure 190: EE/MI Non-Residential Construction Index vs. ABI C&I and Institutional (Historical View)



Source: AIA, U.S. Census.

Figure 191: EE/MI Non-Residential Construction Index vs. ABI C&I and Institutional (Near-Term View)

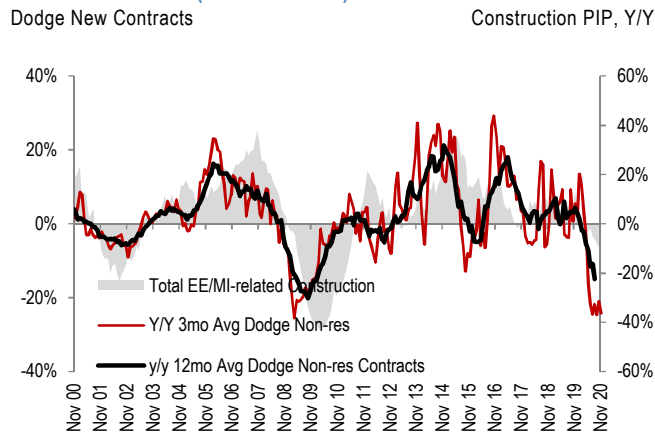


Source: AIA, U.S. Census.

Dodge new contracts

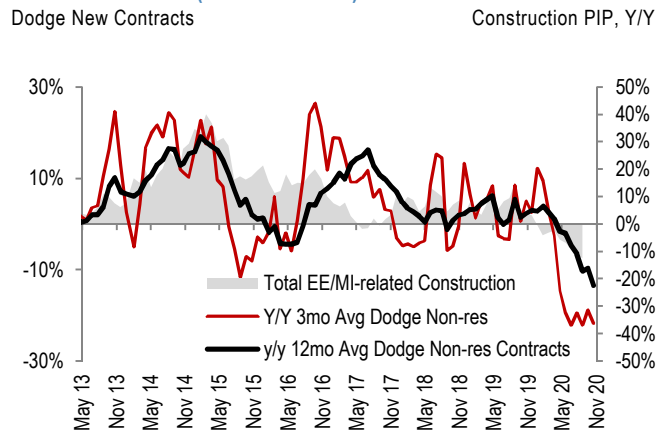
The Dodge new non-res contracts are another commonly watched indicator. Because this data series captures large project contracts as opposed to the run rate of activity, it is more volatile and often overshoots to the upside or downside in any given month. The volatility in this monthly series makes it tougher to draw reasonable conclusions from any short-term trend, but the 12-month rolling average has historically been a more reliable indicator. Also note that Dodge data include 100% of the estimated value of a project in the first month of activity vs. US Census data (which rely on Dodge for leads), which assign spending across the duration of a project. The contracts data from Nov showed new contracts down 36% y/y on a 3mo rolling average, while the 12mo rolling average was down 22%, the lowest numbers since 2009. Prior to COVID-19, Dodge new contracts over 2018 and 2019 remain subdued with LSD/MSD growth following LDD growth in 2017.

Figure 192: Dodge New Non-Res Contracts vs. EE/MI Non-Residential Construction Index (Historical View)



Source: McGraw Hill Dodge, U.S. Census.

Figure 193: Dodge New Non-Res Contracts vs. EE/MI Non-Residential Construction Index (Near-Term View)

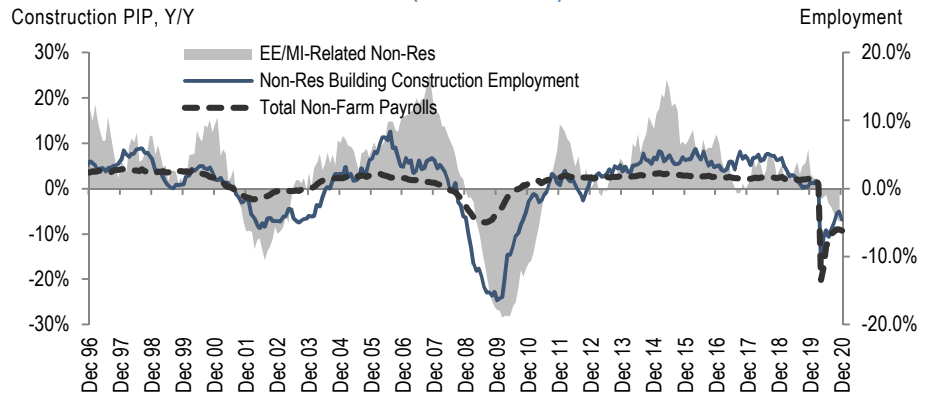


Source: McGraw Hill Dodge, U.S. Census.

Employment data

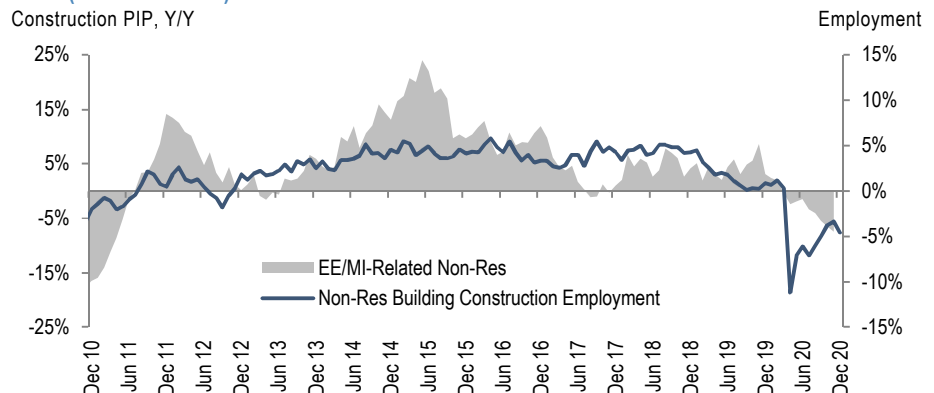
Employment growth in the construction sector can be viewed as another high-level proxy for activity levels – this historical pattern has varied, with employment sometimes lagging put-in-place data and other times leading. Non-Res Building Construction employment declined by 4.6% in Dec vs down 3.4% in Nov, down 3.7% in Oct, down ~6% in 3Q20, down ~8.1% in 2Q20, ~+0.7% in 1Q20 while growth in non-farm payrolls declined by 6.2% in Dec vs down 6.0% in Nov/Oct, down ~6.9% in 3Q20, down ~11.2% in 2Q20, ~+1.2% in 1Q20.

Figure 194: Non-Res Building Construction Employment & Non-Farm Payroll Employees vs. EE/MI Non-Residential Construction Index (Historical View)



Source: BLS, U.S. Census.

Figure 195: Non-Res Building Construction Employment vs. EE/MI Non-Residential Construction Index (Near-Term View)



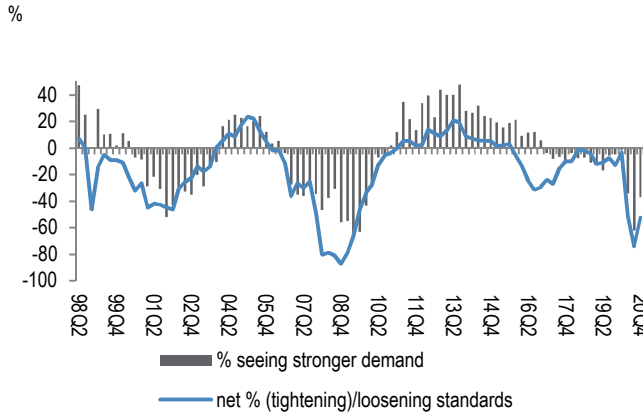
Source: BLS, U.S. Census.

Financial indicators

Stability in financial markets is an important precondition for construction spending and remains relevant, particularly given the role that credit played in the last peak and subsequent downturn. The quarterly FRB loan officers' survey provides a good directional indication of both loan demand and lending standards for non-residential construction loans. Historically, however, the data tends to be better at calling inflection points in the cycle than it does absolute levels of growth mid-cycle.

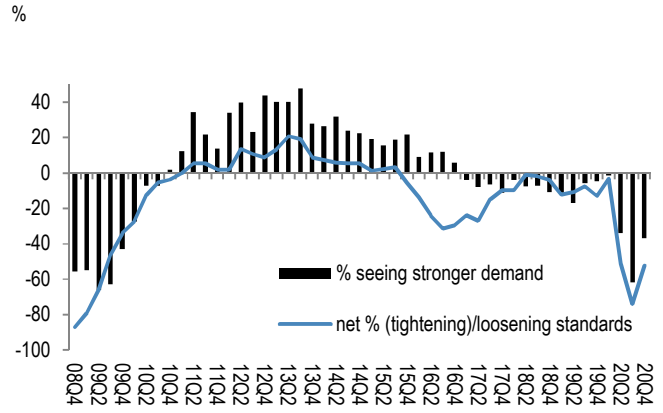
- In the 4Q20 survey, a net 52% of loan officers indicated a tightening of lending standards for non-residential construction loans (74% in 3Q20, 51% in 2Q20, 3% in 1Q20, 13% in 4Q19).
- In terms of loan demand, a net -37% saw stronger loan demand in the 4Q20 survey (-62% in 3Q20, -34% in 2Q20, -2% in 1Q20, -5% in 4Q19, -6% in 3Q19).

Figure 196: Commercial Real Estate Lending Standards and Loan Demand (Fed Loan Officers Survey, Historical View)



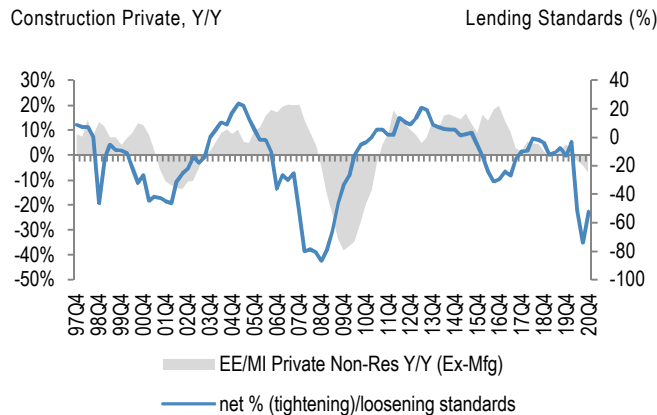
Source: FRB.

Figure 197: Commercial Real Estate Lending Standards and Loan Demand (Fed Loan Officers Survey, Near-Term View)



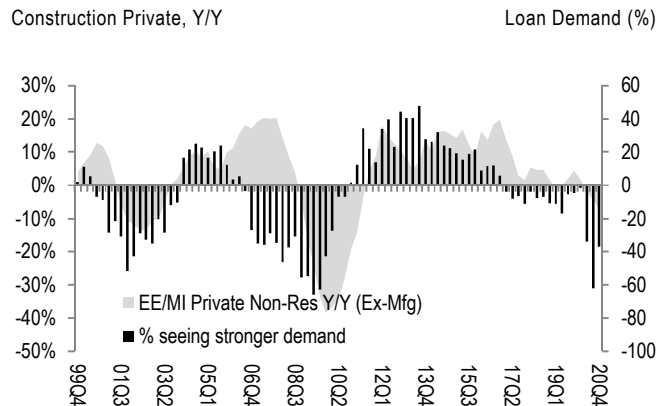
Source: FRB.

Figure 198: Commercial Real Estate Lending Standards vs. EE/MI Non-Residential Private Construction Index



Source: FRB, U.S. Census.

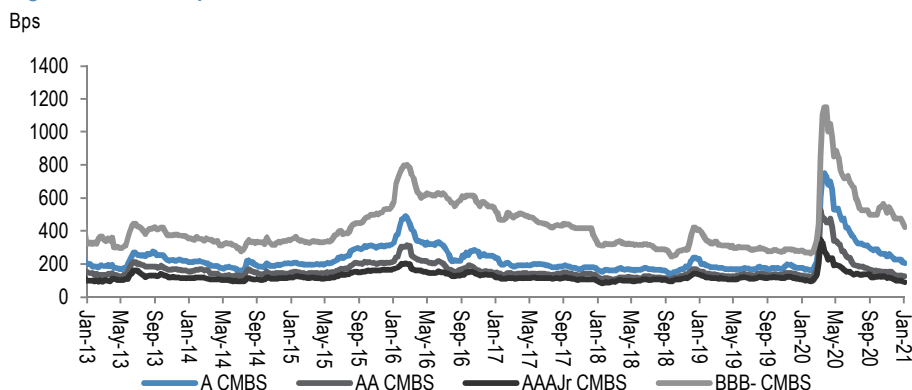
Figure 199: Loan Demand vs. EE/MI Non-Residential Private Construction Index



Source: FRB, U.S. Census.

Looking at CMBS spreads for BBB- bonds vs. others, after some moderation in 2017, data has somewhat stabilized in 2018 YTD, with a recent spike during the COVID-19 spread and a return to normalization most recently.

Figure 200: CMBS Spreads



Source: Bloomberg Finance L.P.

Third-Party Forecasts

Several third-party sources issue forecasts for the non-res construction markets that are typically (but not always) based on the US. Census put-in-place data; in other words, they may not be directly comparable. Below, we show the AIA consensus construction forecast, an average of the major forecasting agencies including McGraw Hill Dodge, Global Insight, and others (updated twice yearly). Current 2021/2022 consensus calls are -5.7% / +3.1% growth, respectively.

Table 85: AIA Consensus Forecasts

	2021E	2022E
Non-Residential Total	-5.7%	3.1%
Commercial Total	-7.1%	3.1%
Office	-9.3%	0.1%
Retail/Other Commercial	-3.5%	5.2%
Hotel	-20.2%	8.8%
Industrial Total	-4.5%	1.5%
Institutional Total	-4.0%	3.2%
Healthcare	1.2%	3.2%
Education	-3.9%	2.7%
Religious	-6.7%	-2.9%
Public Safety	1.0%	-0.4%
Amusement/Recreation	-12.6%	11.1%

Source: AIA.

Table 86: Non-Res Construction Forecasts Have Consistently Been Revised Lower

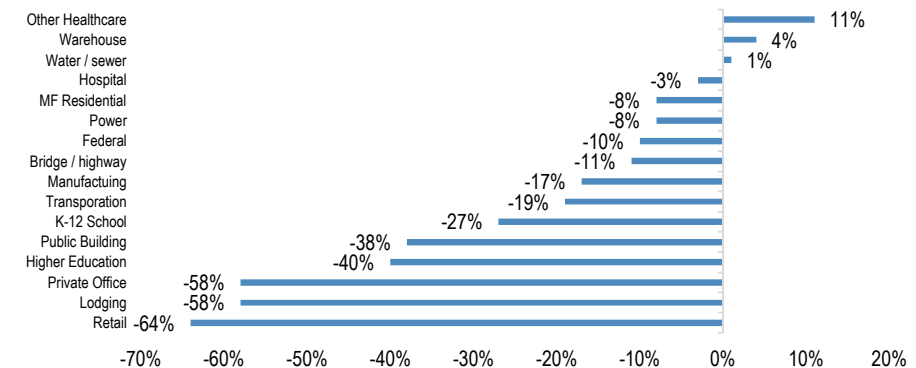
Total non-res construction growth					
	2018	Y/Y Growth in...		2021	2022
		2019	2020		
1H17 forecast	4.90%				
2H17 forecast	3.60%				
1H18 forecast	4.00%	3.90%			
2H18 forecast	4.70%	4.00%			
1H19 forecast		4.40%	2.40%		
2H19 forecast		3.80%	2.40%		
1H20 forecast			1.50%	0.90%	
2H20 forecast			-8.10%	-4.80%	
1H21 forecast				-5.70%	3.10%

Source: AIA.

According to Associated General Contractors (AGC) of America's 2021 Construction Hiring and Business Outlook, 2021 will be a difficult year for construction firms, as the pandemic prompts many projects to be postponed or cancelled, forcing contractors to take longer to build projects and increasing the cost of construction from materials such as steel, cement, liquid asphalt, and aggregates. As per the survey published in January, the % of contractors who expect the dollar value of projects to shrink vs. expand was overwhelmingly negative for 2021, as 44% of firms reported they had projects cancelled in 2020 that had not been rescheduled, with additional cancellations expected in 2021. Even for the first half of the year, 18% of firms report that projects scheduled to start between January and

June have been delayed, and 7% saw projects scheduled to start in the first half of the year being cancelled.

Figure 201: Net % of contractors expecting available dollar value of projects to be higher (lower) by category



Source: AGC.

According to Construct Connect, U.S. Construction Delayed Project reports increased by 18 projects to 8,236 projects as of 25th Jan 2021, from 8,218 over the last week. In total, 4Q20 saw delayed project reports increase by 388 additional projects as compared to ~1600 projects in 3Q20, while on an average, there was an increase of ~6 projects per day in delays in 4Q20 vs ~25 in 3Q20.

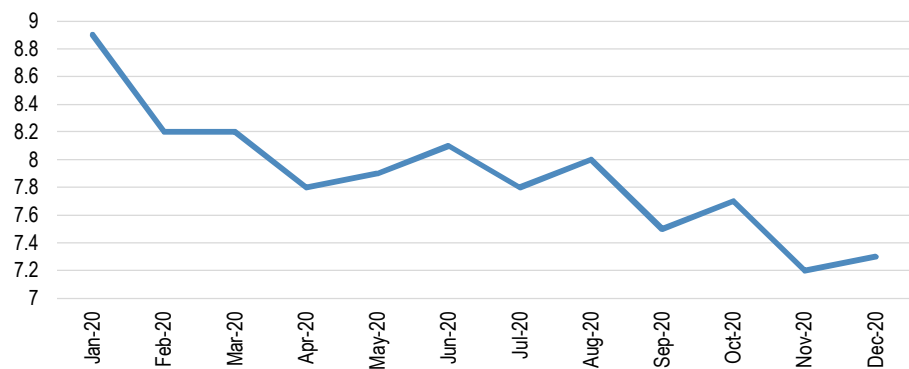
According to Construction Dive, Commercial contractors continue to battle material shortages brought on by the pandemic, according to the Q4 2020 U.S. Chamber of Commerce Commercial Construction Index. The CCI increased by three points — from 57 in Q3 to 60 in Q4 — but is still far beneath 74, the first-quarter score prior to the pandemic. The three big drivers — backlog, revenue expectations and contractor confidence — in the business group’s report “nudged up” slightly from the third quarter, but failed to reach pre-pandemic numbers. According to the report, 71% of contractors surveyed are facing at least one material shortage. Lumber was the most-cited material shortage (31%), followed by steel or electrical supplies other than copper wire (11%) and lighting supplies (10%). Fuel, copper, steel and aluminum have each experienced modest price increases, while concrete’s price has slightly decreased. The difficulty in procuring some construction materials and the cost associated with shortages won’t go away anytime soon, experts say.

The Chamber of Commerce's quarterly report also shows contractors face increasing challenges due to COVID-19, with 83% experiencing product delays, 71% struggling to meet schedule requirements, 68% experiencing delays expected into Q2 of 2021, 58% putting in higher bids on projects, 53% saying major project shutdowns/delays are a top concern, 41% saying material shortages are a severe consequence of COVID-19, 39% turning down work opportunities.

The Associated Builders and Contractors (ABC) backlog indicator is a forward-looking economic metric that reflects the amount of work under contract that will be performed by commercial and industrial construction contractors in the months ahead. Construction Backlog Indicator declined to 7.2 months in November, a decrease of 0.5 months from October’s reading, according to an ABC member survey conducted from Nov. 20 to Dec. 2. Backlog is 1.7 months lower than in November 2019. By industry, Commercial & Industrial backlog stands at 7.2 months in

November (vs 7.5 in October, 9.1 in Nov 2019), Heavy Industrial stands at 4.5 months in November (vs 7.6 in October, 6.7 in Nov 2019), while Infrastructure stands at 8.7 months in November (vs 9.1 in October, 9.6 in Nov 2019).

Figure 202: Construction backlog indicator (in months)



Source: Associated Builders and Contractors

The Construction Confidence Index (CCI), reported by ABC, is a diffusion index that signals construction contractors' expectations for sales, profit margins and staffing levels. The staffing levels index reading remained above the threshold of 50, indicating expectations of expansion over the next six months. The index reading for sales dipped below 50 in November, while the profit margin index reading remained beneath that threshold, indicating expectations of contraction. CCI index reading for sales came in at 49.4 in November (vs 52.7 in October, 63.8 in Nov 2019), profit margins came in at 43.4 in November (vs 47.1 in October, 58.8 in Nov 2019) and staffing came in at 53.8 in November (vs 56.6 in October, 63.6 in Nov 2019).

JCI also provided an outlook for US construction in FY21 in its November earnings call, based on few economic indicators like Dodge, US Census and Bloomberg. They believe that global macro environment remains uncertain, as indicated by the market forecasts. On the non-residential verticals, starting with Industrial, which comprises food/bev, transportation, oil & gas and manufacturing end markets, JCI expects mid-teens declines y/y in 2021, due to depressed expansion owing to trade tensions and COVID-19, post the cyclical peak seen in 2018. Commercial verticals are expected to grow low-single digits, with the recovery led by data centers and warehouses along with some office renovations. Govt. spending is expected to be down HSD as tax revenues remain depressed. Lastly, Institutional verticals like healthcare and education are expected to decline by low-single digits, as some recovery in healthcare is most likely to be offset by lag in education.

Figure 203: JCI end-market expectations (3Q20)

End Market Expectations As We Look Forward

GLOBAL MACRO ENVIRONMENT REMAINS UNCERTAIN, LIMITING VISIBILITY

JCI Revenue Exposure		Fiscal 21 US Construction Outlook		Fiscal 21 GDP Outlook
Other	3%			
Residential	16%	- Ducted HVAC - Ductless HVAC - Security Products	+LSD-MSD	Growth led by single family housing, stable replacement demand
Industrial	21%	- Food & Beverage - Transportation - Oil & Gas - Manufacturing	(MTs)	- CY2018 cyclical peak - Depressed expansion due to trade tensions and COVID
Commercial	25%	- Office & Banks - Retail - Lodging & Hospitality - Data Centers - Warehouse - Sports & Entertainment	+LSD	- Data centers, warehouses lead recovery - Some office renovations
Government	10%	- Federal/National - State & Local	(HSD)	Tax revenues depressed
Institutional	25%	- Healthcare - Education	(LSD)	Recovery mainly led by healthcare with education lagging

Positioned To Out-Perform End Markets

Sources: Dodge Construction Market Forecasting, US Census, JCI Analysis, Bloomberg

18 Johnson Controls International plc — November 8, 2020



Source: JCI company earnings presentation.

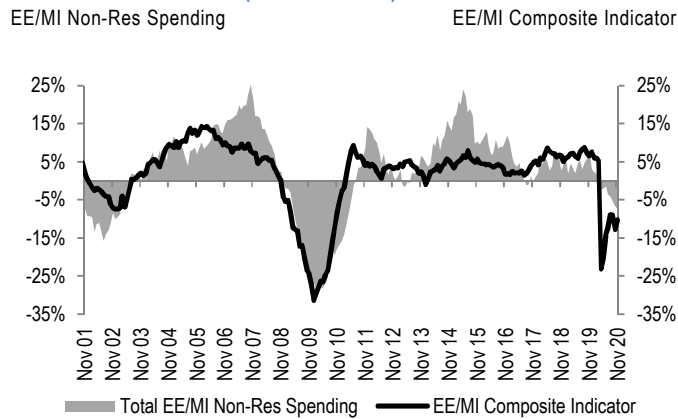
JPM proprietary aggregate non-res indicator

Our aggregate non-res indicator is built up using an average of our vertical-specific indicators, weighted by the total size of that vertical in our JPM EE/MI Non-Res Construction Index. Key inputs include employment growth, vacancy rates, retail sales, industrial production, municipal bond issuances, and property tax receipts.

See our quarterly non-res piece ([link](#)) for more detail.

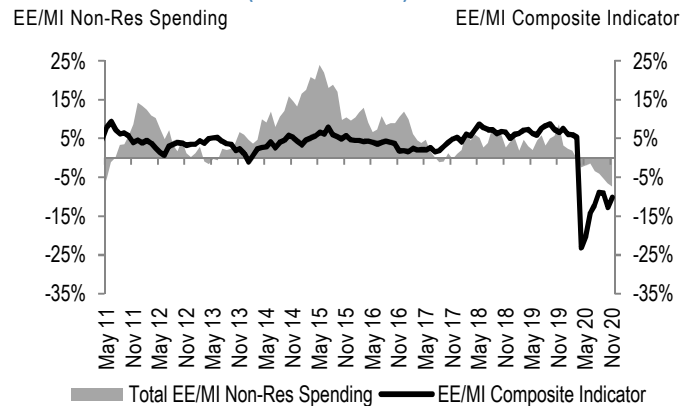
As part of our regular non-res construction analysis, we also take a bottom-up look at construction activity by the individual verticals and the relevant economic indicators for those sectors. The aim of the analysis is to identify real economic activity that drives construction demand, such as employment, vacancy rates, retail sales, or capacity utilization, rather than simply relying on top-down indicators such as the ABI. The charts below highlight our aggregate non-res indicator as compared with our EE/MI non-res construction index. This indicator was directionally accurate through the 2002 downturn but failed to fully capture the cyclical downturn given noise around some of the healthcare sector (the toughest to forecast with macro data), while it was more accurate during the 2009 recession. Our indicator suggests that the solid trends seen in 2018-2019 are now indicating more like 5-10% declines in the near term. Specifically, our JPM aggregate non-res indicator is down 10.2% in Nov, vs. down ~12.7% in Oct, down ~10% in 3Q20, down ~19% in 2Q20 and up ~6% in 1Q20.

Figure 204: EE/MI Composite Non-Res Indicator Versus Construction in EE/MI Non-Res Verticals (Historical View)



Source: U.S. Census, J.P. Morgan.

Figure 205: EE/MI Composite Non-Res Indicator Versus Construction in EE/MI Non-Res Verticals (Near-Term View)



Source: U.S. Census, J.P. Morgan.

Company Growth Rates

The table below shows quarterly growth rates for a broad range of companies (and segments within companies) serving the US non-construction markets. Where possible, we isolate the US/North America revenues, though this is not possible for all companies as many are global in nature. Also keep in mind that these company growth rates will often significantly differ from growth rates in new construction for a number of reasons, including (1) the inclusion of general industrial revenues, (2) a significant replacement/retrofit market, and (3) market outgrowth or share gains, particularly for distributors, and (4) revenues outside the US that can influence growth rates.

Table 87: Summary Table of Growth Rates of EE-MI and Building players

	1Q18	2Q18	3Q18	4Q18	1Q19	2Q19	3Q19	4Q19	1Q20	2Q20	3Q20	4Q20
Diversified Electrical												
Hubbell Electrical	3%	5%	5%	5%	3%	1%	1%	-6%	-3%	-25%	-15%	-11%
Atkore (volume only)	3%	4%	0%	-3%	-2%	1%	8%	3%	-1%	-21%	-10%	-6%
Other Suppliers												
Lennox Commercial HVAC	-2%	10%	-1%	15%	-3%	4%	7%	12%	3%	-28%	-18%	-13%
Trane Technologies	7%	7%	8%	7%	10%	5%	8%	7%	2%	-7%	-1%	-5%
UTX CCS	-3%	0%	7%	5%	6%	6%	6%	2%	-9%	-19%	3%	0%
AYI (overall company)	6%	11%	11%	11%	3%	0%	-12%	-13%	-6%	-20%	-8%	-5%
Assa Abloy Americas	3%	9%	10%	14%	17%	7%	6%	5%	1%	-16%	-4%	-4%
OTIS	1%	2%	4%	5%	7%	4%	4%	4%	-2%	-6%	-1%	1%
Distributors												
WCC Construction	9%	8%	3%	1%	2%	3%	3%	1%	0%	-18%	-10%	-8%
FAST Non-res sales	10%	16%	16%	15%	13%	7%	3%	3%	0%	-10%	-12%	-10%
HDS C&I	14%	15%	12%	6%	5%	2%	2%	4%	-1%	0%	NA	NA
Non-res Segment Average	5%	8%	7%	7%	5%	3%	3%	2%	-1%	-15%	-7%	-6%
Building services/other												
JCI Building Efficiency	2%	5%	7%	6%	6%	6%	3%	3%	-5%	-16%	-6%	-5%
Honeywell Home & Building Products	2%	3%	3%	1%	9%	5%	3%	3%	-6%	-17%	-8%	-4%
Siemens Smart Infrastructure	8%	4%	5%	1%		2%	3%	3%	-1%	-6%	-2%	4%
Schneider Power +Building	9%	9%	7%	8%								
AWI Building Products (Americas)	3%	13%	11%	11%	7%	9%	2%	3%	3%	-25%	-11%	NA
Non-res PIP Total	4%	5%	6%	3%	3%	5%	7%	10%	6%	1%	-2%	-4%
Non-res PIP (EE/MI verticals)	4%	5%	6%	4%	4%	3%	5%	6%	1%	-2%	-4%	-7%

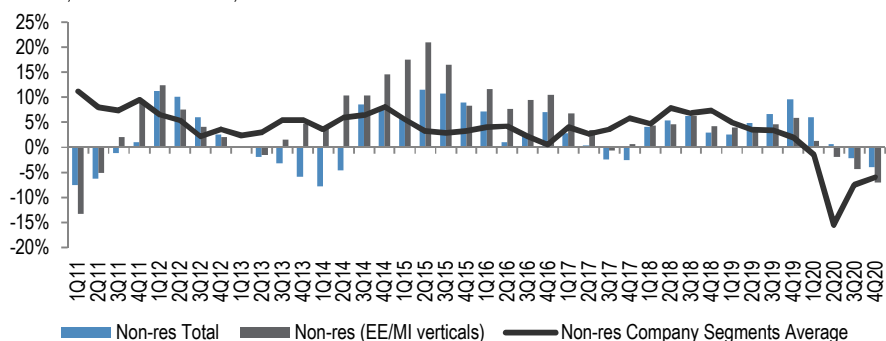
Source: Company reports, J.P. Morgan estimates, Bloomberg Finance L.P.

*Trane Comm. estimates based on approximate growth rates given in slides ("low-single digits", "mid-single digits", etc.); For TYC and JCI yearly estimates are FY Sept-end.

**IR Security Technologies reflects global commercial security business pre-spin; Allegion's North America segment reflects regional sales for combined commercial and residential businesses

Figure 206: Non-Res Construction vs. Related-Company Revenue Growth

% Y/Y; Non-res EE/MI verticals include office, lodging, commercial, educational, healthcare; segment growth average includes HUBB Electrical, Atkore, ETN Electrical Americas, IR Trane Commercial HVAC, TYC Fire (Old), Assa Abloy Americas, TYC NA Install & Service, Acuity, UTX CCS, LII Commercial HVAC, HDS, FAST Non-Res, WCC Construction, Atkore Volumes



Source: Company reports, US Census, J.P. Morgan.

We think that breaking down the types of growth rates above further provides insight into the various divergences we expect in '21 due to the types of the businesses they are. Some are critical service businesses like at Otis, some are less critical services like the HVAC names and some are more heavily equipment related. In the table below, we show different non-res related businesses by type of application, across critical/less-critical, long-cycle equipment/short-cycle and hybrid applications.

Because of these differences, companies will continue to see differing rates of performance into 2021. The pecking order for types of applications with the most growth to the largest declines is non-essential services, essential services, light commercial equipment and then heavy commercial equipment. 4Q for long cycle equipment is influenced by some catch up in Otis Americas business, which is unsustainable given recent order trends. Ultimately HVAC saw the greatest declines in 2020 and will have the easiest comparisons, though forecasts for spending next year make the outlook more of a challenge.

Table 88: Non-Res Businesses By Type of Application

	1Q20	2Q20	3Q20	4Q20	2020	2021E
Critical						
Otis Services	3%	-3%	-1%	-1%	-1%	+2-4%
Less-critical						
JCI Americas Services	2%	-7%	-3%	-2%	-3%	+LSD-MSD %
Trane Americas Services	0%	-5%	2%	2%	~flat	"growth"
Carrier Global Commercial Services	0%	-15%	-8%	-10%	(HSD)	"DD growth"
Long cycle equip						
JCI Americas Install	2%	-16%	-9%	-9%	-9%	+LSD %
Otis NA Equipment	-9%	-20%	0%	18%	-3%	+LSD-MSD %
Carrier Global Commercial Applied	-20%	-12%	-2%	1%	(HSD)	NA
Hybrid						
JCI Americas Applied (Equip + Svc)	1%	-8%	-5%	-5%	(MSD)	+LSD-MSD %
Trane Commercial Equip	5%	-7%	-3%	-5%	(LSD/MSD)	+LSD %
LII Commercial	3%	-28%	-18%	-13%	-16%	+MSD %
Carrier Light Commercial	-5%	-20%	-13%	-10%	-14%	NA
Short cycle						
HUBB Construction/Energy	2%	-23%	-15%	-9%	-11%	non-res (2-4%), industrial +3-5%
WCC -EES segment	-2%	-19%	-10%	-8%	-10%	+LSD
Assa Abloy Americas	1%	-16%	-4%	-4%	(MSD)	NA
Atkore- volume only	-1%	-21%	-10%	-6%	-10%	NA
Allegion- Americas non-res	8%	-15%	-12%	-12%	(HSD)	NA
AWI Building Products (Americas)	3%	-25%	-11%	NA	NA	NA
Total Average	0%	-15%	-7%	-4%		
<i>Services</i>	2%	-5%	-1%	0%		
<i>Equipment</i>	-1%	-18%	-9%	-4%		
<i>Short Cycle</i>	0%	-19%	-10%	-8%		

Source: Company reports and J.P. Morgan estimates. Note: NA = Not Available; Blue Indicates JPM estimate.

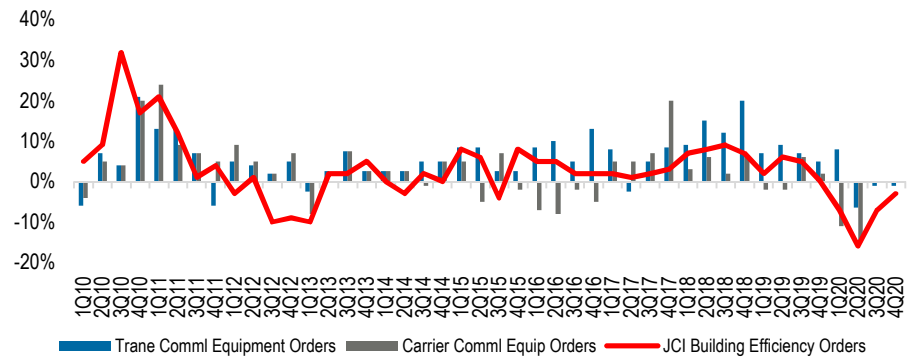
Commercial HVAC Order/Revenue Trends Reflect Recent End Market Challenges

The heavy replacement component of commercial HVAC means that orders/revenue trends can diverge somewhat from commercial construction trends, but they tend to track each other over time. The charts below show that OEM orders and revenues inflected in 2010, the point at which non-res fundamentals stabilized and replacement deferrals ended, leading to double-digit growth for several quarters before a pause in 2011 and moderation in 2012-14, while 2015-16 saw acceleration in new construction activity, which carried over into strong trends in 2016 and 2017, and 2018 growth generally remained solid but showed more moderation, with 2019 decelerating even further. For 2020, the commercial HVAC market was negatively impacted by the COVID-19 pandemic, with orders/revs tracking down 5-10% for the year, bottoming in 2Q at down 10-15%, with 2H down about 5% overall. Light

commercial saw bigger declines than applied as per LII's commercial equipment revs down ~16%, with 2Q down 28%.

Figure 207: Commercial HVAC Orders of Major Players

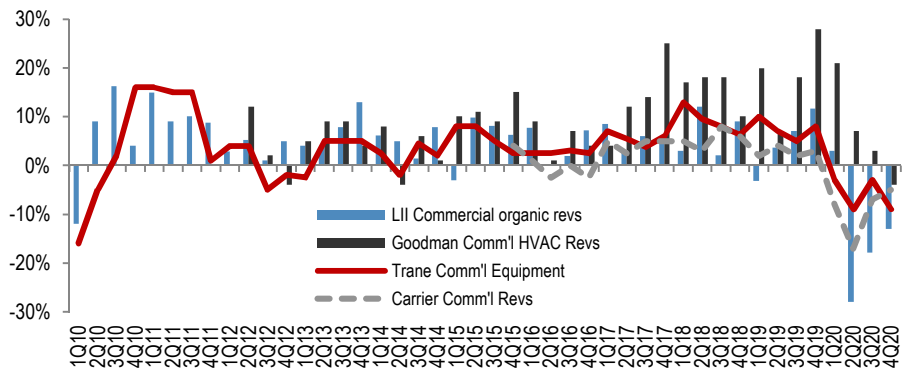
Y/Y growth



Source: Company reports

Figure 208: Commercial HVAC Revenues of Major Public Players - Historical View

Y/Y growth



Source: Company reports

Unitary recovery tends to lead applied off the bottom

Note that the commercial HVAC industry breaks down between light commercial unitary equipment and the larger applied systems (see our technology primer in the back of this report for more detail). Historically, commercial unitary typically leads growth as the “earlier cycle” segment of the market, given the higher percentage of replacement demand and the fact that unitary products are smaller-ticket/quicker-turn items. Applied systems have historically been the “later cycle” segment, outgrowing when large new construction projects start to return, such as the late 1990s or 2007-08. The nuances to this rule of thumb are that (1) applied systems have a larger international presence so will perform well when regions like Asia are strong, as we saw in 2010; and (2) applied systems have a larger institutional exposure in the US versus unitary, which are largely commercial, and this has driven relatively slower applied growth in past years.

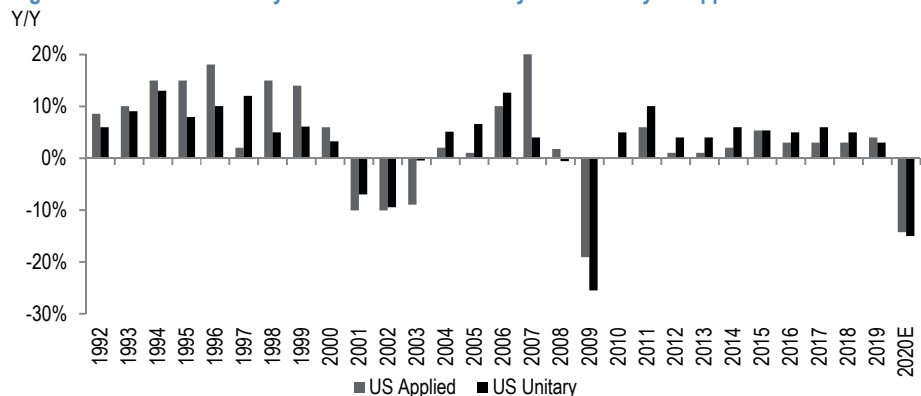
Table 89: Key Qualitative Differences Between Commercial Unitary and Applied HVAC

	Demand mix	Cycle Timing	End Market Verticals	Geographic Scope
Unitary	Slightly higher percentage of replacement demand (shorter product life), less service revenue	Quicker turn product, higher % of replacement demand tends to recover first in an economic recovery	More “commercial” (office, retail) exposure and somewhat less institutional	Still a majority US product, despite some growth abroad
Applied	Slightly higher percentage of new construction demand (longer product life), more service revenue	Longer lead time product (3-6mo order to delivery), with more use in large buildings that often recover late in cycle	Relatively higher percentage of institutional demand (hospitals, government, academic, etc)	More geographically diverse, particularly EM exposure

Source: J.P. Morgan

We see below that, although trends in commercial unitary have broadly followed trends in the commercial construction market, its move off the bottom is actually more in line with the real-time leading indicators like the ABI, a dynamic that happened again this cycle. We would attribute this to the fact that replacement demand kicks in as the economy improves but before new construction and that the smaller unitary equipment can be replaced sooner once business confidence returns.

Figure 209: Trends in Unitary Markets Have Historically Led Later-Cycle Applied

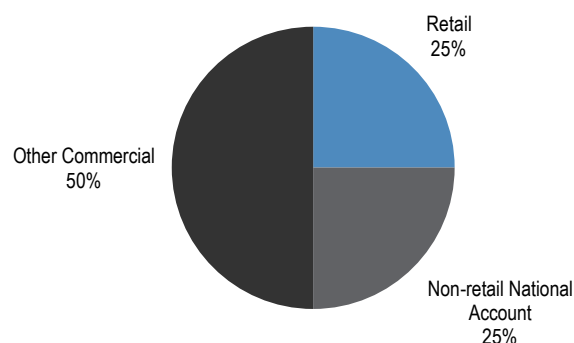


Source: J.P. Morgan estimates

We expect to see some bifurcation between unitary and applied going forward. Aside from the cycle dynamics discussed above, unitary will likely be impacted by the changing landscape of retail. With the rise of e-commerce and the decline in spending at traditional brick and mortar stores, the retail footprint continues to shrink dramatically, affecting square footage growth. Retail pressures are most relevant for Lennox, which has seen lumpiness in the commercial segment in the past from retail national account pushouts. National accounts represent about half of the commercial business, and retail is about half of national accounts. The company has been aggressively expanding into new verticals like hospitality, restaurant, medical, and entertainment, which could help mitigate pressure from retail, but with ~25% exposure to the overall segment headwinds in retail would be negative for Lennox.

Figure 210: Lennox Retail Exposure

% Commercial Segment



Source: Company reports and J.P. Morgan estimates

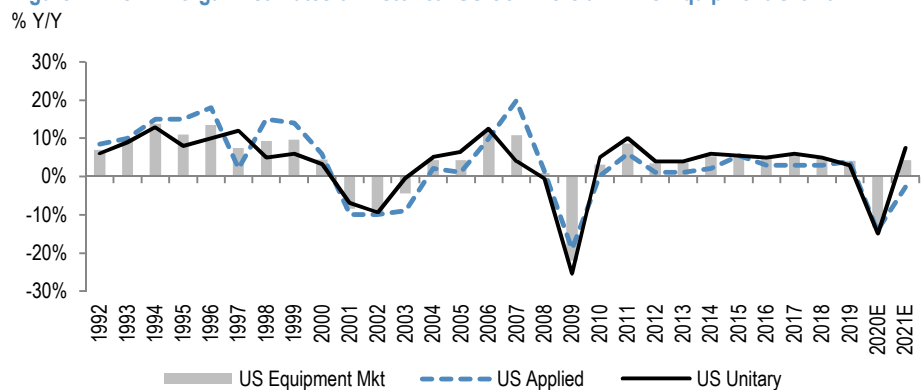
JPM North America Commercial HVAC Equipment Market Model

The model below provides our overview for NA commercial HVAC, the biggest market for the major OEMs, representing 50-75% of major commercial OEMs' equipment revenues.

Starting point: baseline of market estimates, separating new versus replacement demand

Unlike in residential, there is not one commonly accepted market growth rate for the commercial HVAC market. While AHRI has broken out factory shipments of commercial unitary products in recent years, shipments of large applied chillers (an AHRI data series discontinued in 2005) will vary in size and scope, making industry revenues harder to quantify. Many of the major OEMs like Trane, Carrier, and Lennox have often provided market growth estimates in their 10-Ks or presentations. We use this information, along with AHRI data and BSRIA estimates of the Americas applied markets, to triangulate growth rates historically. We show these estimates below.

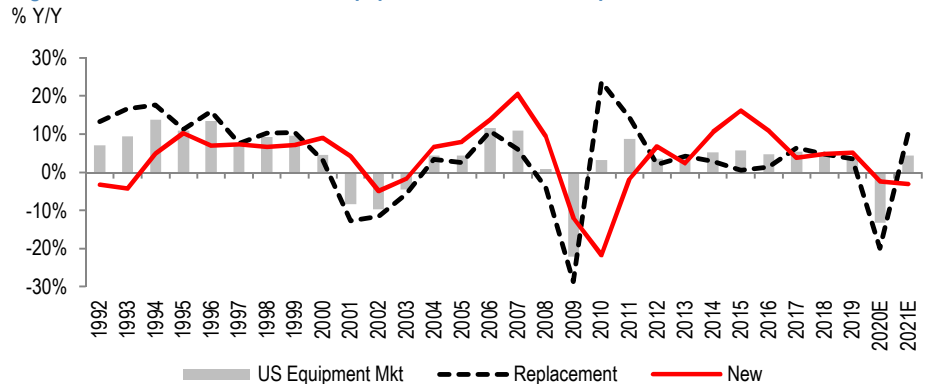
Figure 211: J.P. Morgan Estimates of Historical US Commercial HVAC Equipment Growth



Source: J.P. Morgan estimates.

We then separate demand into new construction and replacement. We base this division on the simplifying assumption that new systems grow in line with an end-market-weighted average of US Census construction put-in-place data. The demand not accounted for by new construction is then assumed as replacement/retrofit.

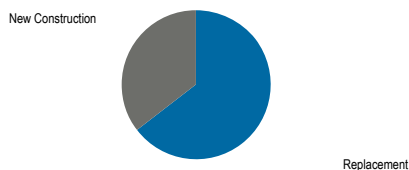
Figure 212: US Commercial HVAC Equipment—New Versus Replacement Estimates



Source: J.P. Morgan estimates.

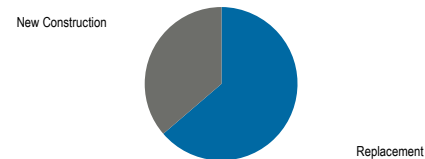
We estimate that, through the cycle, the commercial HVAC equipment market is split between units for new construction (~35%) and units for replacement/retrofit activity (~65%). This will likely fluctuate depending on the point in the cycle, however, and given the outsized declines in non-residential construction, we estimate the market in 2013 was ~70% replacement, likely rebounding back closer toward 60-65% in 2016-18. Within applied and unitary, we estimate that the unitary market is slightly more slanted toward replacement (~75%), mainly because of the units' shorter life, which averages 10-15 years versus 20-25 years for the larger applied systems.

Figure 213: US Commercial HVAC Market (Through-Cycle Average)



Source: J.P. Morgan estimates.

Figure 214: US Commercial HVAC Market (2019)



Source: J.P. Morgan estimates.

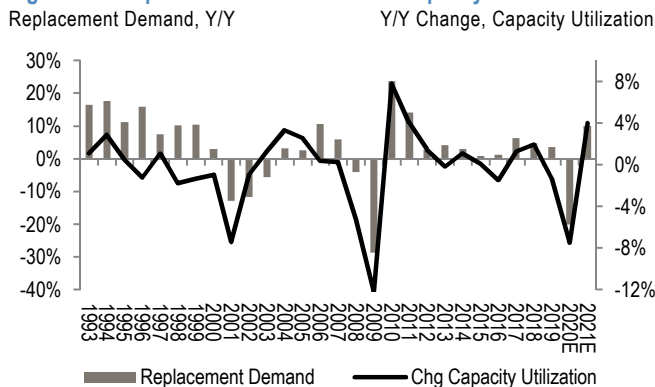
Replacement demand moves with economic indicators...

While sales related to new construction are more straightforward to forecast, replacement demand can be volatile and identifying its drivers can be more challenging. Fundamentally, we believe that commercial HVAC is similar to other capital goods in that replacing an old unit will trade upfront capital costs for lower operating costs (in this case, energy savings). Like other capital goods, there is a cyclical component to these investments as customers are more likely to spend money when their own cash flow and business fundamentals are strongest. With this in mind, there are a few macro indicators that we see as important and that have correlated well historically.

- *Vacancy rates*—A significant portion of HVAC equipment is sold into office/retail verticals, and vacancy rates are a good proxy for cash flow among leased properties. Replacement activity tends to pick up when vacancy rates peak, just ahead of an uptick in occupancy, as building owners likely become more confident of future cash flows.

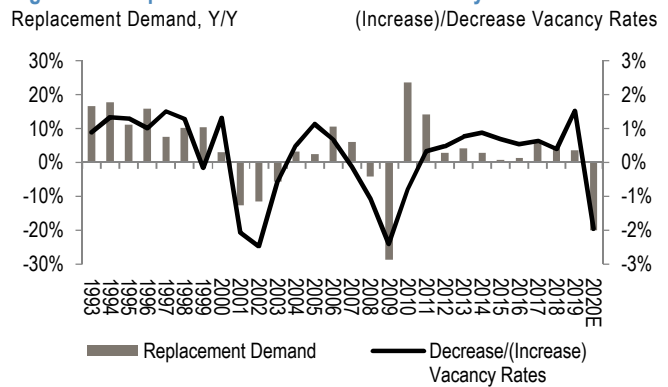
- *Real estate returns*—Similar to vacancy rates but measures the financial value of the underlying properties as building owners are more likely to invest in properties as values are increasing. Again, replacement activity appears to pick up as indicators stabilize.
- *Manufacturing capacity utilization*—Approximately 15% of industry demand comes from industrial customers, and a pickup in utilization rates typically portends a pickup in replacement for units in those factories.
- *Corporate profits*—Another broad measure of business profitability, meant to reflect business cash flow and investment appetite. Note that many commercial HVAC systems are in owner-occupied buildings or factories, with capex funded by cash profits.

Figure 215: Replacement Demand Versus Capacity Utilization



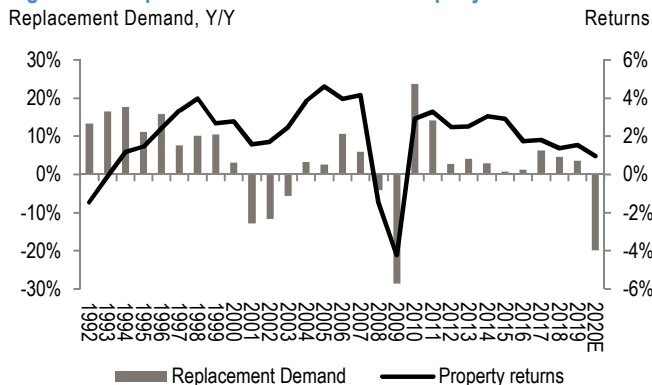
Source: FRB, J.P. Morgan estimates.

Figure 216: Replacement Demand Versus Vacancy Rates



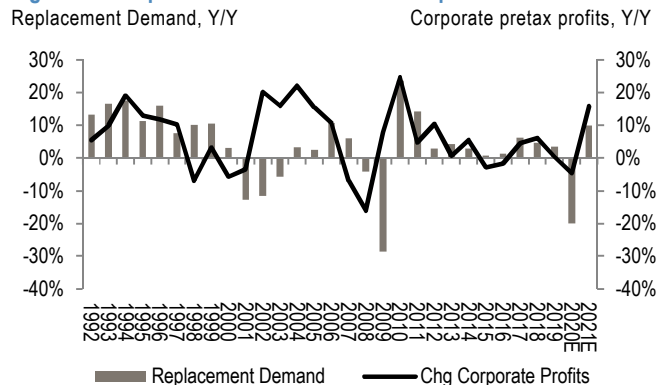
Source: BEA, Caldwell Banker, CB Richard Ellis, NAR, J.P. Morgan estimates.

Figure 217: Replacement Demand Versus Property Returns



Source: NCREIF, J.P. Morgan estimates.

Figure 218: Replacement Demand Versus Corporate Profits

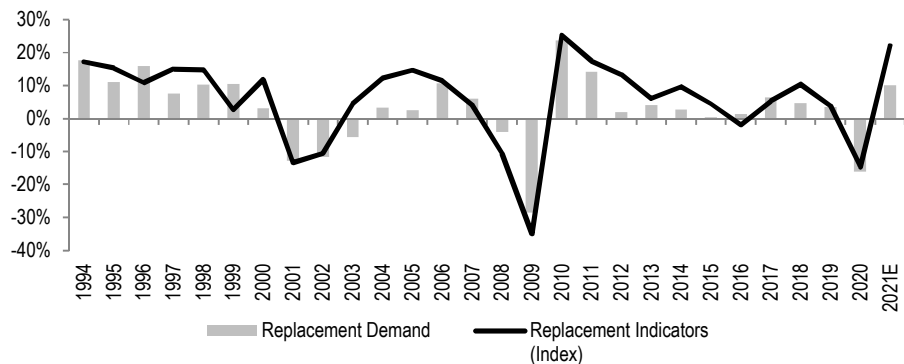


Source: BEA, J.P. Morgan estimates.

To this end, we have created an index to understand the historical drivers of replacement activity better. Our index is weighted to the change in vacancy rates (50%), business spending (30%), and capacity utilization (20%), since those have the highest historical correlation with replacement growth. This index has proven directionally accurate, with ~90% correlation with replacement demand since the early 1990s.

Figure 219: Commercial HVAC Replacement Demand vs. Macro Index

Y/Y Change



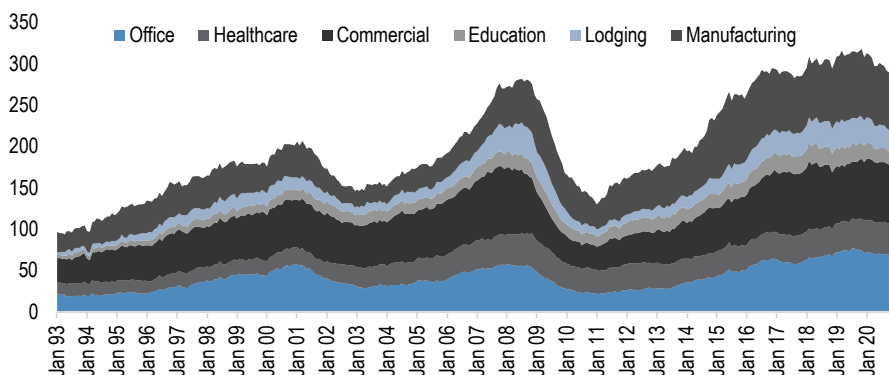
Source: J.P. Morgan estimates.

...But Age of Installed Base an Important Factor

While there is clearly a cyclical component to CHVAC replacement demand, the age of the installed base is ultimately a major factor in determining the need to replace equipment, driven by unit breaks as well as potential paybacks on newer energy efficient systems. On this front, the installed bases built in the US are appearing to reach a ripe age for replacement, 25 years past the 1990s building boom, fertile ground for an increase in activity. We start by looking at non-res spending. We don't have data back that far for public spending by vertical, but we do have private non-res by vertical, which shows that building related spend ramped through the 1990s, before ultimately peaking in the 2000/2001 period and then falling off for a period of time. This shows the degree of spending during the 1990s that we are referring to.

Figure 220: Private Non-Res Spending in Buildings Related Verticals

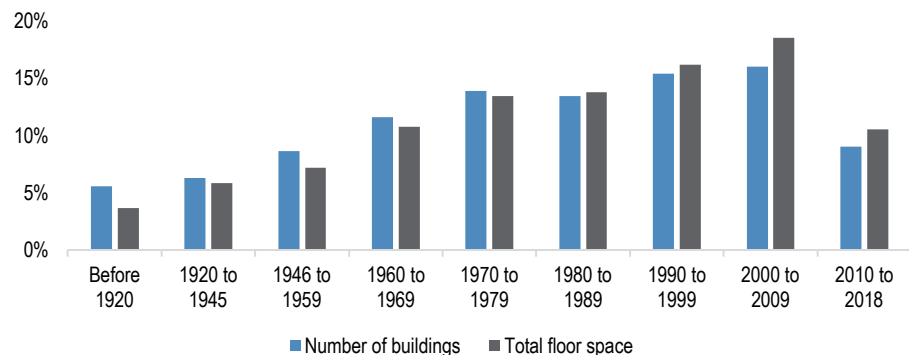
\$ millions, annualized rate



Source: US Census.

Next, we look at the US building stock. According to the EIA's 2018 Commercial Buildings Energy Consumption Survey, more than half of US commercial buildings were built between 1960-1999, while 25% have been built since 2000. Looking closer at the data, we see that the 1990-1999 cohort represents among the biggest ones in terms of both total buildings and floorspace, with a median age of around ~25 currently. The number of buildings and amount of floorspace constructed from 1990-1999 was up 15% and 17% vs the 1980-1989 period, which compares to a -4%/+3% change for the 1980-1989 cohort vs the one in 1970-1979, highlighting the increased opportunity.

Figure 221: US Buildings/Floor Space Constructed By Age Cohort

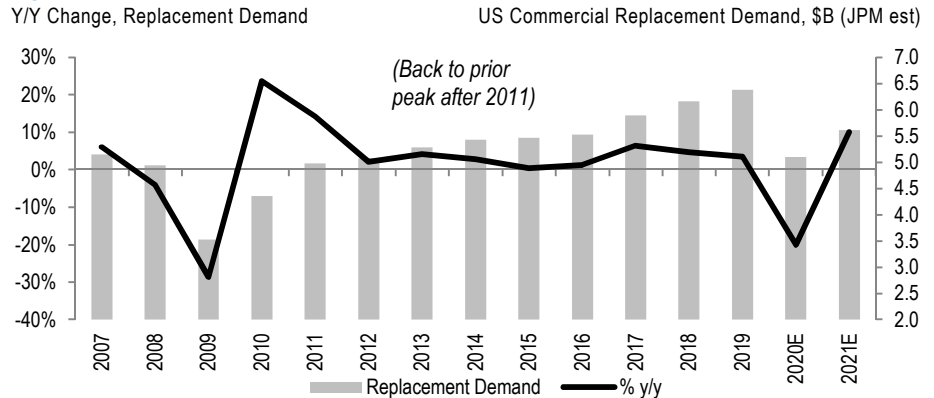


Source: EIA CBECS

Replacement demand bounced hard in 2010-11, grew LSD-MSD through 2019, and now we expect a return to post crisis levels

One of the interesting dynamics this cycle was the surge in replacement demand for commercial HVAC in 2010-11, even as construction markets continued to languish, as the depth of the trough likely caused many customers to defer routine investments that required “catch-up spending,” particularly on the light commercial side. Also, both manufacturing activity and corporate profits saw a V-shaped recovery off the bottom, a positive for industrial exposures, as well as owner-occupied properties broadly. Third, while office construction took longer to recover, financial indicators stabilized as early as mid-2010, likely giving building owners confidence that they had seen the worst of the downturn. Indeed, if we take our estimate of replacement demand, much of the rebound in 2010-11 was merely recouping the declines seen through the downturn. This dynamic lead to all-time replacement highs in 2019, and we now anticipate a significant drop-off, back to post-crisis levels for replacement demand, followed by a rebound in 2021.

Figure 222: Commercial Replacement Demand Regained Pre-Crisis Levels in 2011, Saw all-time high in 2019, and we expect to drop to 2011/2012 levels in 2020



After MSD growth in Construction, we assume a LSD decline in 2020 and 2021

For non-res construction markets, we assume a LSD decline in 2020 and 2021, followed by a rebound to 3% growth in 2022, after 4-5% growth from 2017-19. There is no widely accepted end-market split for the broader HVAC market, but we estimate it at ~60% commercial (office, retail, manufacturing, etc.) and ~40% institutional (education, healthcare, government). Note that we generally exclude other verticals that show up in the US Census construction data, such as power or highway construction, as these have limited HVAC content. For purposes of our market model, we build a proxy index of the major market accounts, which we build back historically and assume equipment for new construction in line with put-in-place spending.

Figure 223: Assumed Proxy for US Commercial HVAC Construction
%, based on US Census put-in-place data

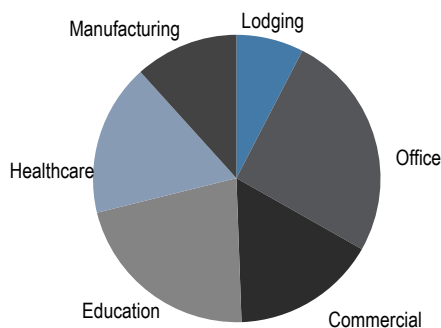


Figure 224: Assumed New Construction Growth (Based on Weighted Index)
% Y/Y

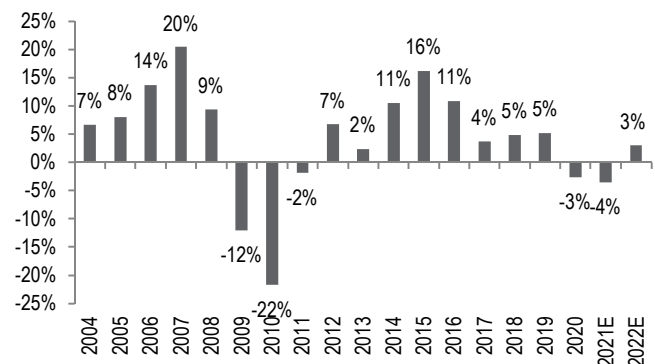


Table 90: Non-Res Put-in-Place Data by Vertical (Actual and Assumed in JPM Model)

% Y/Y

	Lodging	Office	Commercial	Education	Healthcare	Manufacturing	Weighted
2004	15%	7%	9%	0%	10%	9%	7%
2005	4%	8%	5%	7%	7%	23%	8%
2006	41%	18%	9%	7%	12%	14%	14%
2007	58%	20%	16%	13%	14%	24%	20%
2008	25%	5%	-3%	8%	7%	33%	9%
2009	-29%	-24%	-36%	-1%	-4%	8%	-12%
2010	-54%	-27%	-27%	-14%	-12%	-29%	-22%
2011	-22%	-5%	6%	-4%	2%	-2%	-2%
2012	18%	5%	11%	0%	6%	18%	7%
2013	25%	0%	13%	-7%	-4%	10%	2%
2014	24%	23%	18%	1%	-5%	15%	11%
2015	31%	20%	7%	7%	3%	38%	16%
2016	23%	21%	17%	8%	2%	-4%	11%
2017	6%	2%	12%	6%	6%	-11%	4%
2018	10%	11%	-1%	5%	1%	2%	5%
2019	5%	11%	-7%	4%	5%	11%	5%
2020	-14%	-4%	4%	-1%	4%	-10%	-3%
2021E	-17%	-5%	1%	1%	-1%	-9%	-4%
2022E	0%	5%	3%	1%	3%	5%	3%

Source: US Census and J.P. Morgan estimates.

All in, LDD declines for US commercial equipment markets in 2020, followed by LSD/MSD growth in 2021 and MSD in 2022

We believe that the market in '20 was down 11% for US commercial HVAC equipment, with 3-4% expected growth in 2021 and 6% for 2022, following a long period of LSD/MSD % growth (2012-2019). Our macro assumptions underlying the replacement demand bounce back for 2021 include a recovering environment for business spending and facility utilization, partly offset by more muted performance on vacancies, albeit better than the declines seen during 2020.

Table 91: JPM US Commercial HVAC Model

\$ billions

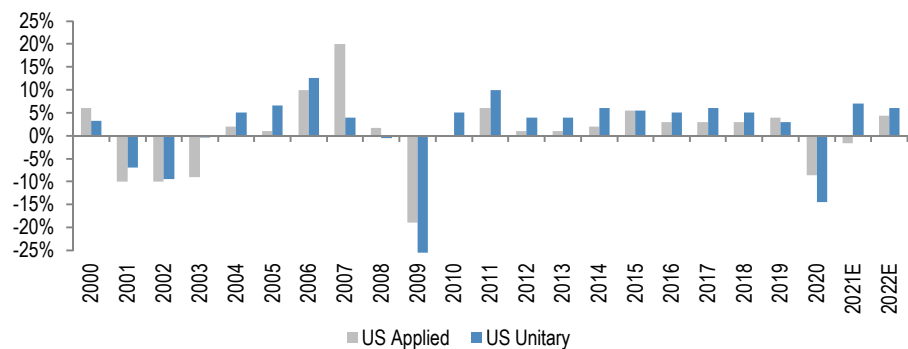
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021E	2022E
Equipment (\$B)											
New	2.4	2.4	2.7	3.1	3.5	3.6	3.8	4.0	3.9	3.7	3.8
Replacement	5.1	5.3	5.4	5.5	5.5	5.9	6.2	6.4	5.4	5.9	6.4
Y/Y Growth											
New	7%	2%	11%	16%	11%	4%	5%	5%	-3%	-4%	3%
Replacement	2%	4%	3%	0%	1%	6%	5%	3%	-16%	10%	8%
Total equipment	4%	4%	5%	6%	5%	5%	5%	4%	-11%	4%	6%
Equipment by type (\$B)											
Applied	3.2	3.2	3.3	3.5	3.6	3.7	3.8	4.0	3.6	3.6	3.7
Y/Y	1%	1%	2%	5%	3%	3%	3%	4%	-9%	-2%	4%
Unitary	3.9	4.1	4.3	4.6	4.8	5.1	5.3	5.5	4.7	5.0	5.3
Y/Y	4%	4%	6%	5%	5%	6%	5%	3%	-15%	7%	6%
Macro Assumptions											
New Non-Res Construction	7%	2%	11%	16%	11%	4%	5%	5%	-3%	-4%	3%
% Chg Capacity Utilization	1%	0%	1%	0%	-1%	1%	2%	-1%	-7%	7%	
% Chg Business Spending	11%	5%	7%	3%	-2%	3%	8%	2%	-5%	17%	
% (Inc)/Dec in Vacancies	0%	1%	1%	1%	1%	1%	0%	2%	-3%	0%	
Chg. Corporate Profits	10%	1%	5%	-3%	-2%	4%	6%	0%	-5%	19%	

Source: J.P. Morgan estimates.

2020 better than the GFC, with unitary bouncing back in 2021 and applied still down modestly

By market segment, we expect roughly similar declines from commercial unitary versus applied, but with applied slightly better similar to what we saw in 2009 as institutional holds up a bit better than commercial markets, but we think applied declines could continue for another year given the lagging nature of the sales cycle vs. unitary.

Figure 225: US Equipment Growth Forecasts – Applied Versus Unitary



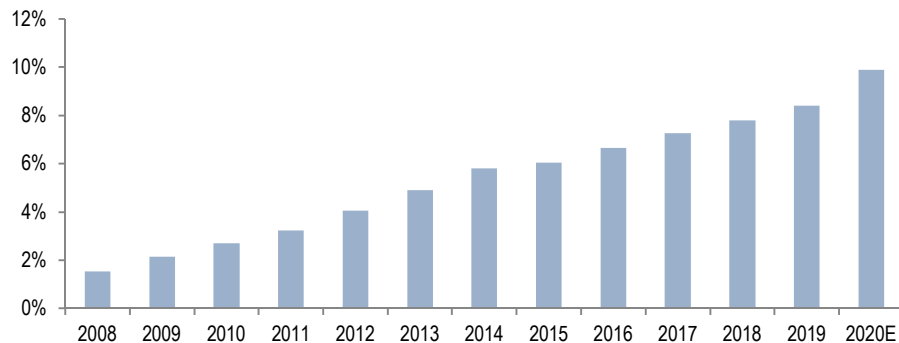
Source: J.P. Morgan estimates.

What about ductless?

The ductless variable refrigerant flow (VRF) product has been growing in importance to the US commercial market. JARN estimates the commercial VRF market size each year, and growth had generally been in the 25% range earlier this cycle before cooling to ~10% in 2015 and ~15% in 2016/17. In 2018, the US VRF market grew by ~18% according to JARN, reaching 62.8K units and in 2019 it grew by ~10%. On average since 2010 VRF has grown ~20% y/y. Our base case for growth moving forward is ~10-15%. We believe ductless now totals 5-10% of overall US commercial revenues. While ductless demand is still relatively small in size, we estimate that most of this incremental penetration has come at the expense of both applied systems as well as large unitary. Part of this reflects the higher proportion of sales to institutional areas, which have been a target for the VRF markets initially as those customers can often tolerate longer payback periods. Overall, this remains a market that should grow above industry average for the intermediate future and carve out a larger space in the market, but is not a huge negative impact to legacy applied or unitary players.

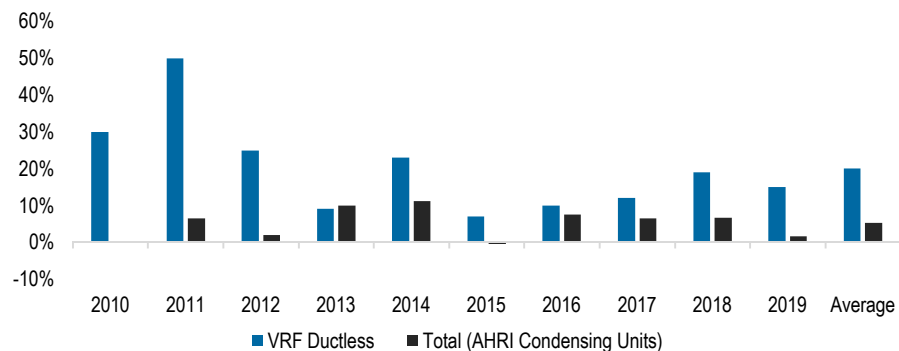
Figure 226: Ductless Commercial VRF Has Grown to 5-10% Share of the Market

% of US commercial HVAC market (revenues)



Source: J.P. Morgan estimates.

Figure 227: Ductless vs Total Unit Growth

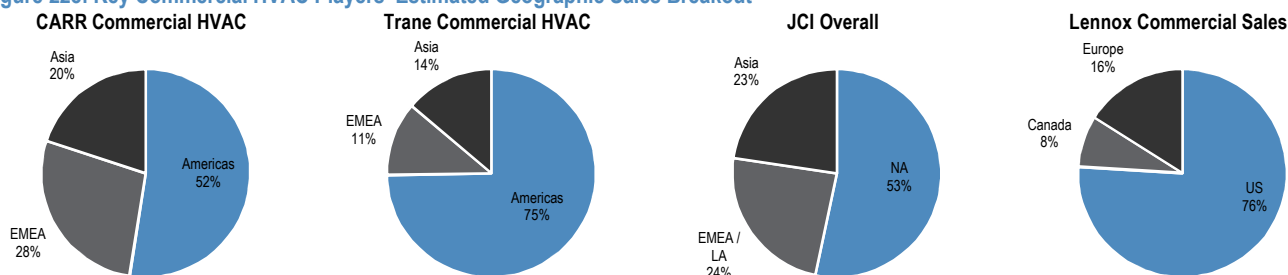


Source: J.P. Morgan estimates, Company data. AHRI

International Markets

Unlike the residential unitary market, which is almost solely focused on the US, there are some significant international opportunities for commercial HVAC. In the past, this has largely been about applied systems in emerging markets, but there is also some commercial unitary product that is increasingly going abroad. On a relative basis, it's still NA centric, with an average exposure of about 60-65% US for HVAC players versus the overall 55% for the EE/MI group.

Figure 228: Key Commercial HVAC Players' Estimated Geographic Sales Breakout



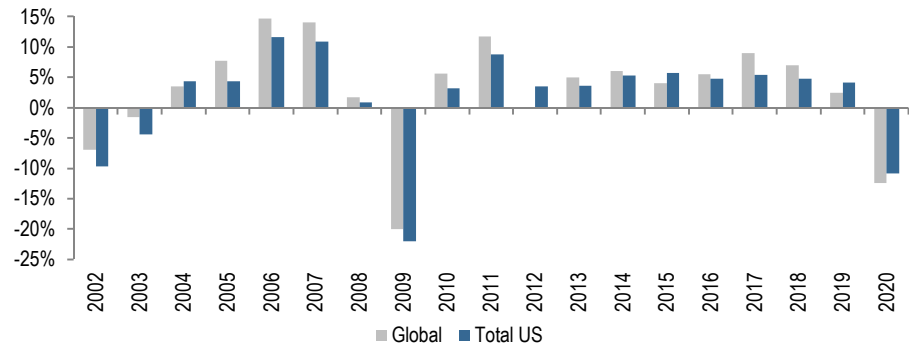
Source: Company reports, J.P. Morgan estimates. Note: LII sales include everything ex-residential.

We estimate non-US markets have added an average LSD to OEM revenue growth annually through 2019, but down LDD-LT % in 2020

This report focuses primarily on the US OEMs that play primarily in unitary/applied (not ductless) equipment, and there is no widely accepted data set available to quantify the growth of these addressable markets globally, though JARN and BSRIA do provide estimates. When we look at historical revenue growth rates for these OEMs in comparison to US market growth, we estimate that non-US markets have added an average LSD to OEM revenue growth annually. This implies non-US markets growing, on average, 4-5% higher than US markets. We estimate most recent years have been closer to flattish, with 2015 international actually down (contributing negatively) while 2016 recovered slightly to ~+1% (JARN estimated global HVAC market up 5.5%). 2017 accelerated with international growth at ~4% as the global economy recovered (JARN estimated global HVAC market up 9%) while 2018 contributed a more normal 2% (global HVAC market up ~7%). For 2019, we believe international growth was once again a drag on the total (global HVAC market up 2-3% as per JARN). For 2020, the data has yet to come out but judging by competitor growth rates, we believe international commercial markets were down LDD to LT%.

Figure 229: JPM Estimates of US vs. Global Equipment Growth for US OEMs

% Y/Y, ex-currency



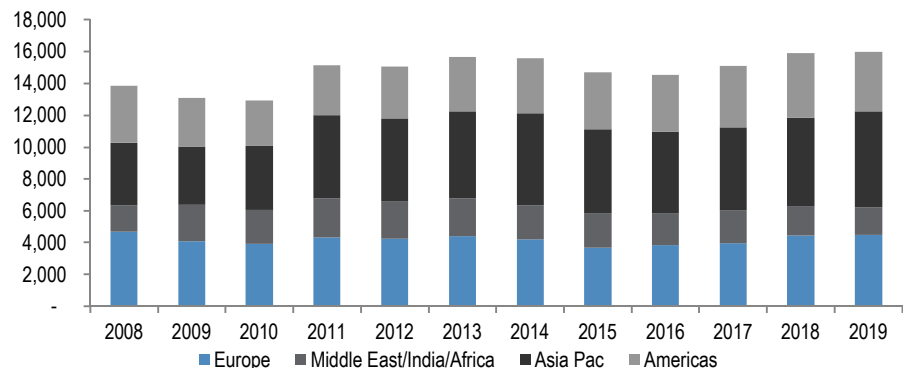
Source: Company data, J.P. Morgan estimates

A look at global applied markets: demand swings this cycle, with EMs key, but overall up just LSD CAGR from 2009-2019

The chart below shows BSRIA's estimates (in \$) of the global markets for chillers and airside equipment, a good proxy for the global applied markets (2019 latest dataset). Here, we see a sharp upswing in 2011 as markets recovered, not just in the US but also globally. Demand moderated in 2012, largely driven by Asia and the slowing in China, while 2013 saw a widespread lift across most regions but driven primarily by a recovery in Asia Pacific. 2014 was down with strong growth in APAC offset by weakness in MEA, with sluggishness in US and Europe, and 2015 deteriorated further driven by Europe and APAC declines. 2016 was better but still down as APAC continued to decline while MEA was down 7%, while 2017 saw a nice recovery across regions, with strength in Americas. The global market grew solidly again in 2018, but only slightly in 2019, followed by significant declines in 2020 due to the COVID-19 pandemic, albeit with some recovery as restrictions eased, led by rebounds in pharma, hospital and data center sectors. In the ten years since 2009 the data indicate only ~2% CAGR, led by ~5% in Asia Pac, partly offset by ~3% decline in MEIA regions.

Figure 230: BSRIA Estimates of Global Chiller and Airside Equipment

\$ millions



Source: BSRIA

Table 92: BSRIA Estimates of Global Chiller and Airside Equipment, Y/Y Growth

% Y/Y

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Europe	-13%	-4%	10%	-2%	3%	-4%	-12%	5%	2%	12%	1%
Middle East/India/Africa	42%	-9%	16%	-5%	2%	-10%	2%	-7%	2%	-10%	-6%
Asia Pac	-8%	10%	29%	0%	5%	6%	-9%	-4%	3%	6%	9%
Americas	-15%	-6%	10%	4%	5%	0%	4%	0%	8%	5%	-8%
Global	-6%	-1%	17%	0%	4%	-1%	-6%	-1%	4%	5%	1%

Source: BSRIA and J.P. Morgan estimates

Company data show a similar picture: EM strong in 2010-11, slower since but recovery in 2017 with a decline in 2020

The increased emerging market exposure was a noticeable tailwind at the inflection of this cycle as the commercial HVAC OEMs were able to capitalize on the strong growth in these regions in 2010-11. This was particularly true in the first several quarters of the recovery, when emerging regions outgrew the US/Europe. In 2012, however, the tailwind from international growth stalled, reflecting the moderation in emerging markets and China in particular. More recently, non-US demand has improved in 2017-2018 as the global economy recovered. With the pandemic outbreak, we see a reversion back to a decline in orders and revenue for OEMs, however we expect the order declines to be more short-lived than we saw in the GFC.

Table 93: Trane Quarterly Commercial HVAC Organic Revenue Growth and Regional Comments

	Total (organic)	Americas	EMEA	Asia
2Q10	1%	"Up slightly"	Declines	Growth
3Q10	6%	"Up slightly"	"Up slightly"	"Strong Growth"
4Q10	13%	10%	5%	"Strong Growth"
1Q11	12%	12%	8%	"Strong Growth"
2Q11	12%	10%	13%	"Strong Growth"
3Q11	9%	7%	ROW +13%	n/a
4Q11	1%	-2%	Up MSD	Up MSD
1Q12	4%	Up MSD	"Up"	"Down Slightly"
2Q12	4%	Up MSD	Dn MSD	Flat
3Q12	"Flat"	"Down"	Dn Mid-teens	"Up slightly"
4Q12	"Flat"	Up LSD	Dn MSD	Dn LSD
1Q13	Dn LSD	Dn LSD	Dn LSD	Dn LSD
2Q13	Up LSD	"Up Slightly"	Up Low-teens	Up Low-teens
3Q13	Up LSD	"Up Slightly"	Up Mid-teens	Up MSD
4Q13	Up MSD	Up MSD	Up MSD	Up Low-teens
1Q14	Up LSD	Flat	Up MSD	Up MSD
2Q14	Up LSD	Up LSD	Up HSD	"Down"
3Q14	Up MSD	Up MSD	Up LSD	"Down"
4Q14	Up MSD	Up MSD	Up Mid-teens	"Down"
1Q15	Up MSD	8%	22%	-3%
2Q15	Up MSD	4%	3%	-4%
3Q15	Up LSD	7%	10%	-3%
4Q15	Up MSD	3%	2%	9%
1Q16	Up MSD	5%	5%	13%
2Q16	Up MSD	13%	-3%	"Down"
3Q16	Up MSD	Up HSD	Down MSD	Flat
4Q16	Up MSD	Up low teens	Up MSD	Up High teens
1Q17	Up MSD	Up HSD	Slightly down	Up LSD
2Q17	Up MSD	Down MSD		Up HSD
3Q17	Up MSD	Up MSD	Up HSD	Up high teens
4Q17	Up MSD	Up LDD	Up significantly	Up LSD
1Q18	13%	Up	Up	Up
2Q18	10%	Up	Up	Up
3Q18	8%	Up	Up	Up
4Q18	6%	Up	Dn	Up
1Q19	10%	Up	Modestly up	Up
2Q19	7%	Up	Down	Up
3Q19	5%	Up	Up	Up
4Q19	8%	Up	Up	Up
1Q20	-3%	Up	Up	Down
2Q20	-9%	Down	Down	Down
3Q20	-3%	Flat	Down	Down
4Q20	Down MSD	Down MSD	Down MSD	Down HSD

Source: Company reports.

Table 94: Carrier Quarterly Commercial HVAC Equipment Order Growth

	Total
1Q10	-3%
2Q10	5%
3Q10	4%
4Q10	20%
1Q11	24%
2Q11	9%
3Q11	7%
4Q11	6%
1Q12	8%
2Q12	5%
3Q12	2%
4Q12	7%
1Q13	-8%
2Q13	0%
3Q13	15%
4Q13	5%
1Q14	15%
2Q14	Up LSD
3Q14	
4Q14	Up MSD
1Q15	Up MSD
2Q15	Down MSD
3Q15	Up MSD
4Q15	Down LSD
1Q16	Down MSD
2Q16	Down HSD
3Q16	Down LSD
4Q16	Down MSD
1Q17	Up MSD
2Q17	Up MSD
3Q17	+7%
4Q17	+20%
1Q18	Up LSD
2Q18	6%
3Q18	Up LSD
4Q18	6%
1Q19	Down LSD
2Q19	+HSD
3Q19	+LSD
4Q19	+LSD
1Q20	-LSD
2Q20	-MT
3Q20	Flat
4Q20	Flat

Source: Company reports

Table 95: JCI Quarterly Comm'l HVAC Growth Rates

	Total- CHVAC	Total- Applied	NA Applied	EMEALA Applied	APAC Applied	GP- Applied	BMS	Applied	GP- Light Comm'l
4Q17 (F1Q)			+HSD				+MSD	+MSD	+LSD
1Q18 (F2Q)			+LSD				+MSD	up slightly	+LSD
2Q18 (F3Q)			+MSD				+HSD	+HSD	+MSD
3Q18 (F4Q)			+MSD				+HT	+LDD	+LSD
4Q18 (F1Q)			+MSD				+LDD	+HT	+MT
1Q19 (F2Q)			+MSD				+LDD	+MT	+MT
2Q19 (F3Q)			+HSD				+LDD	+MSD	+HSD
3Q19 (F4Q)			+HSD				+LSD	+HSD	+HSD
4Q19 (F1Q)			+LSD	+HSD	flat		+HSD	(MSD)	+LSD
1Q20 (F2Q)			+LSD	(MSD)	(HT)	(MT)			(MSD)
2Q20 (F3Q)			(HSD)	(MT)	(MSD)	(low-20s)			(mid-20s)
3Q20 (F4Q)	(HSD)	(MSD)	(MSD)	(HSD)	(MSD)	(HSD)			(LT)
4Q20 (F1Q)	(MSD)	(MSD)	(MSD)	(LDD)	flat	(LSD)			(LDD)

Source: Company reports. Note: Commercial HVAC includes BMS controls.

Potential Medium Term Opportunities: IAQ, ESG, and the Biden Plan (But First We Have a Cycle)

An interesting theme that COVID-19 has to some extent pushed to the center of attention is that of declining non-res occupancy and building efficiency, with new post-virus norms such as social distancing, increased work-from-home measures and an enhanced focus on cleaner air. In addition to this near-term increased focus, companies' ESG plans also provide support for this trend to continue, with clear targets set in the context of the Paris Agreement. First off, we do not see much that changes the shape of the cycle/downturn as building owners are facing the uncertainty around format and occupancy. We do expect an intermediate-term positive impact from increased focus on building efficiency, where it's not going to be as simple as replacing an HVAC piece of equipment, but more about taking a holistic approach to system replacement and reconfiguration, notably to address how to abide by stricter hygiene/social distancing policies, be more energy efficient, and pull more renewable energy to reduce carbon emissions (which we discuss further below).

Diving into the ramifications of COVID-19, new hygiene standards and policies should drive demand for increased transparency and control on indoor air quality, thermal screening, social distancing, and the health status of buildings, which should benefit providers of air filtration systems and building controls. Social distancing norms also bring some interesting dynamics around occupant flow. On non-res occupancy, the declining trend in square footage per worker has been underway since the '08-'09 cycle, and an offset to non-res growth. From where we are today, even if working from home measures stay in place to some extent, we see a scenario where the declining trend in square footage per worker that has persisted over time, eventually stabilizes as companies settle their plans around their office footprint, and perhaps more suburban branches could open to support employees moving further away from cities and urban areas.

COVID-19 aside, most ESG strategies which we will show in a bit talk to replacing outdated HVAC/lighting systems for higher efficiency systems, expanding the use of building controls, building management systems and smart building solutions, to reduce emissions and improve the efficiency of energy use, in the pursuit of green building certifications. On policy, the Biden campaign infrastructure plan which we will also discuss to "upgrade" 4 mm commercial buildings over the next 4 years looks significant vs. a ~6 mm unit building stock and a mere ~100,000 buildings

currently “green,” but the term is vague and green certification has many different levels such that the ultimate economic impact for suppliers is still uncertain. The potential for incentives likely translates into a pause in projects currently in the pipeline, more of a headwind near term but tailwind in the intermediate term.

Trying to gauge the impact for the next cycle, non-res growth has slowed over the last three cycles (excluding periods of declines), with non-res spending falling from 10% in 1994-2000 and 2003-2008, to 7% 2011-2020, and EE/MI composite indicator falling from 12% to 8% and to 5% in the same periods. Green buildings became a theme over the past decade, but this trend didn’t drive enough growth to overcome the underlying decline in square footage per worker that started in the 1990s.

Looking forward to the next cycle, as we discussed above, we could see the trend in square footage per worker stabilize. Additionally, the 2020 downturn has reset US non-res lower after 5 years of being above trend, and COVID-19 has placed more emphasis on safety in commercial buildings, such that a more positive fundamental backdrop could provide some lift. In terms of quantifying the lift, we believe the decline in square footage per worker occurred mainly in the 1990s-early 2000s, and since '08/'09, with the trend relatively stable in between those two periods. Extrapolating from the difference in growth between 2003-2008 and 2011-2020, we believe a stabilization in the square footage per worker trend and COVID-19 dynamics could drive a bit extra growth next cycle.

Lastly, on IAQ, COVID-19 raises questions around how buildings can protect against airborne spread of infectious diseases. Our checks suggest there has been a lot of research on how ventilation impacts air quality in buildings, but to date there hasn’t been much dent into the minimum standards (ASHRAE 62.1 / 62.2). While standards will eventually change, there is no clear timeline, and we think this results in majority of the market looking for incremental ways to deliver better indoor air quality without having to get to medical-grade (ASHRAE 170), MERV-13 type approaches to filtration (HEPA) and minimum hourly air change thresholds seen in those facilities (6 an up). This will include a combination of upgrades to filtration, more air cleaners, and increased air changes (6 per hour is a good number from research, somewhat beyond what most are already doing). We start here.

Indoor Air Quality a Hot Topic, But Market Expectations Seem Ahead of Reality

Management teams since the onset of COVID-19 have across the board called out the increased interest in both resi and commercial indoor air quality (IAQ), focusing on building safety and security, and remote monitoring. We put more weight on the commercial side of this story given the greater complexity and health management considerations in multi-occupant settings. Commentary from management teams indicates that the potential opportunity here could be significant, with the initial interest in the air quality assessments high, however with the actual translation to orders unknown. Two changes mentioned across the OEM calls were accelerated air exchanges and filter upgrades, both of which require system analysis and engineering changes to be effective, and perhaps catalyze some full replacements, though we think in this economy the big ticket activity is likely into the future. For example, to upgrade air filters, the whole system will have to undergo various degrees of upgrades or enhancements due to air flow constrictions on the new filters while accelerated air exchanges will drive a degree of stress on the system that will require some new equipment and ultimately more service. These are just some examples, but the point is that getting to IAQ and proper efficiency, it is not as simple as merely replacing an air filter and then saying the building is safe, but rather requires full

system upgrades or at a minimum service changes to increase airflow or fan speeds to accommodate for new filtration systems. The ripple effects of upgrading one part of a building HVAC system could find its way to even further need for service and equipment installs, and while it is early days, we see this as a tailwind worth keeping track of in the post-COVID-19 world. As for the opportunity for the OEMs, this is a long-term story and we are not quite sure there is enough customer wallet commitment in this type of cycle to have a material financial impact in the intermediate term. Indeed, as per the above, we see more of an incremental approach by building owners, not necessarily the full blown move some may have initially envisioned toward medical-grade IAQ across the board.

As noted above, hospital and healthcare facilities must comply with ASHRAE and other regulatory standards with respect to air change rates, humidity requirements, and pressurization. ASHRAE standard 62.1 is the most commonly referenced minimum standard for office buildings while standard 170 is for healthcare facilities. ASHRAE suggested outdoor air ventilation rate for air changes per hour is an important metric to use as it gives insights to the different levels of IAQ needed in different buildings. For example, ASHRAE recommends air changes of 0.35-1 for homes, 1-2 for hotel rooms, 2-3 for offices and retail shops, 5-6 for schools, 4-8 for sports facilities, and 6-8 for restaurants. Meanwhile hospitals typically operate at 20-25 air changes per hour, and some as high as 40.

Table 96: Air changes per hour of different locations

ACH

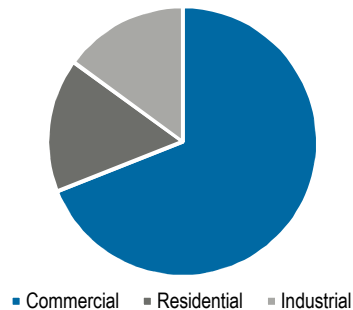
Location Type	ACH
Homes	0.35-1
Hotel Rooms	1-2
Offices	2-3
Retail Shops	2-3
Schools	5-6
Sports Facilities	4-8
Restaurants	6-8
Hospitals	20-40

Source: ASHRAE and HFM magazine

Zooming out, for a more macro perspective on IAQ and air purifiers and filters, we turn to JARN for industry analysis on the topic. Overall, the industry has seen growth in the past few years, with the trends being accelerated recently with the onset of COVID-19. In Asia, a sudden surge in shipments in April was seen, due to the revived supply chain originating in China along with greater interest in IAQ overall. In Japan, for example, shipments of air purifiers increased by ~65% y/y in April, while room air conditioner units decreased by 8%. In Japan, Panasonic, Daikin, Sharp, Hitachi, Mitsubishi Electric, and Fujitsu General are the major brands of air purifiers. Due to the rapid increase in demand from the beginning of April, these manufacturers have significantly increased their sales, and some models are out of stock. Several manufacturers are considering adding production lines in anticipation of a future increase in demand. In the United States, interest is increasing as well with OEMs coming out with new products such as Carrier's OptiClean portable negative air machine, which we discuss in further detail below. In Europe, some manufacturers have said orders of air purifiers have been increasing since the latter part of February, up nearly 5x y/y. Below we see the global air purifier market is more heavily weighted toward commercial applications such as hospitals, schools,

hotels and restaurants with resi making up a smaller percentage of the total market, around 15%, however we expect interest in IAQ at home will likely increase.

Figure 231: Global Air Purifier Market Share by Application



Source: JARN

Below we look at individual strategies and offerings for the main HVAC OEMs. LII's structural exposure to residential and light commercial does not play as much to this thematic, which is mostly larger, more complex commercial buildings, so we focus instead on JCI, TT, CARR, and Daikin below, but we also provide a table with their most recent commentary on the subject.

JCI: The company in mid-2020 announced their OpenBlue system, which houses and standardizes all of their connected services and equipment. The idea here is to combine JCI products, applications, technology and services in one package that is easily applicable to multiple customers and verticals for end-market users seeking to upgrade and enhance their building both from a sustainability perspective and an IAQ and building safety perspective. JCI has a track record of extensive investment into upgrading various HVAC lines over the past few years—notably they acquired AtmosAir in 2018, which is a leading manufacturer of air purification systems, and the company manufactures AtmosAir purification as an option within air handling systems.

TT: Trane has talked a lot about its IAQ Audits. Here, a technician will assess a building's IAQ and recommend enhancements such as new filters, fresh air exchanges, fan speed changes, etc. Right now this revenue is through service, and the company hopes these audits will translate to actual equipment and service orders in the near term. Some of these audits will result in small changes, other multi-year upgrades, but regardless the audits present an opportunity as Trane engages more with customers. Interestingly, management also discussed the future possibility for federal or state level regulation on IAQ in the post-COVID-19 world with actual metrics for building safety. They related this to EnergyStar or LEED for sustainability and while there is no official metric system yet to measure a building's IAQ, this trend is something to keep an eye on especially as return to work and normalcy accelerates. The company notes that for the most part, IAQ consumables are not made by them but rather bought and then branded.

Turning to specific products within Trane, the company has several IAQ related products for both resi and commercial applications. CleanEffects Filter is Trane's resi application that is ~8x more effective than other HEPA filters and Trane's Catalytic Air Cleaner System (TCAS) for commercial systems uses photocatalytic oxidation (PCO) to reduce microorganisms. The air cleaning technology is effective

in converting volatile organic compounds to less harmful ones and can be installed on new Trane cataloged and custom equipment as well as retrofitted onto existing air cleaning systems.

Looking at Trane's JV with Mitsubishi Electric, METUS, the organization has introduced two new IAQ related products recently. First, the Lossnay RVX Energy Recovery Ventilators (ERV) improve efficiency by tempering outside air with heat from the exhaust air stream before supplying it into the space. The Lossnay is a total heat-exchange ventilation system that helps building owners meet ventilation requirements and improve IAQ. Next, METUS recently introduced the M-Series SUZ outdoor unit with Hyper-Heating Inverter (H2i) technology for resi and light commercial applications. The unit is designed to improve efficiency and IAQ, maintaining performance at outdoor temperatures as low as -13°F (-25°C) through the use of H2i. The technology we have seen coming from Mitsubishi is a clear advantage for Trane with their JV, evidenced by the new product launches as well as METUS being awarded the National Association of Home Builders 2019 Global Innovation Award for their SLZ-KF four-way ceiling model with 20+ SEER Rating.

CARR: We view Carrier as lagging in its commercial equipment and controls portfolio and its services attachment rate, the combination of which is key in this endeavor of tracking and acting on information, especially in the post-COVID-19 world where demand for remote monitoring will likely be higher. Similar to Trane, Carrier has Air Quality Assessments that have seen a dramatic rise recently. It is part of their consulting services and the goal here is to test air quality and develop and implement upgrades to systems with a focus on filtration, ventilation, airflow, and controls. Looking at Carrier products, their OptiClean Negative Air Machine is an "air scrubber" that helps to clean contaminated air and prevent the spread of disease. These are mainly made for use in hospitals, and recently Carrier came out with a larger model specifically targeted for hospital and school use with demand rising in those two verticals from COVID-19. We also see their ActivAir Hybrid Hydronic Air Terminal as a key element of their IAQ portfolio, with the product providing increased ventilation and increased outside air, the two primary factors in IAQ.

Daikin: Daikin is equipped with a unique technology that oxidizes and decomposes harmful substances by streamer discharge in its air purifiers. The high-grade model MCK70W, which uses a twin streamer that doubles the conventional streamer effect and tough ageless fit utility (TAFU) filter, is selling well. Daikin has filter manufacturers under its umbrella: American Air Filter (AAF), Dinair, Flanders, and Nippon Muki, so its strengths in filters can be utilized in the development of air purifiers. Currently, Daikin's air purifiers are mainly produced in China, but in anticipation of future global demand expansion, the company has begun considering construction of new production lines in Malaysia along with domestic production. Its sales target for air purifiers has reportedly been increased by about 30% compared with the initial plan.

Table 97: IAQ Commentary

JCI
Completed remaining minority stake in Qolsys, a proven technology disrupter in the security products market delivering cloud-based intrusions and smart building solutions. Under OpenBlue Healthy Buildings label, they brought mobile applications aimed at accelerating building occupancy, by filling confidence and assisting in the management of COVID-19 risk. Furthermore they continue to invest in digital assets like building controls and sensors to fully integrate the OpenBlue platform. With current attachment rate for services averaging 35%, management believes OpenBlue will add 3-4% per year to services growth rates as it moves across the installed base overtime. Demand for IAQ and Healthy Building Solutions remain a key focus area. They have seen significant uptick in interest from customers, since the beginning of the pandemic. For exl, YTD sales of KOCH MERV 13 filters are up >400% y/y. 2H resi IAQ products were up 84% y/y. Revenues were smaller but offset some of the weakness we are seeing. Over the next three years, they expect to gain nice share and plan to launch over 150 new products in fiscal '21 in healthy buildings. IAQ is front and center with all customer engagement with the education that has been had around air quality and the impact that that has in mitigating the impact of the virus - finding the right balance between air quality as well as energy efficiency and is based on science-backed recommendations on clean air delivery rate - includes ventilation, filtration, disinfection and then isolation and it's also combined with centers around temperature, humidity, occupancy and ultimately ties to building controls. Commercial HVAC is very attractive with long-term secular drivers that align with capabilities in equipment as well as digital and the secular trends of energy efficiency and sustainability, which opens up opportunity to be able to build on additional services. And then ultimately capitalizing on the emerging trend with indoor air quality and healthy buildings. IAQ - 1.7 trillion of square footage (according to Navigant) and about a quarter of that is non-resi space and then within that, today's level of air purification is well below what would be now in this environment perceived as being acceptable. So solution includes maintaining or maximizing the ventilation, bringing the highest level of filtration. So, it might be today MERV 8 and moving towards MERV 13. It includes deploying potential disinfection technologies isolation in healthcare. They deliver clean air delivery rate, which is clean air changes per hour with a level of a purification, also optimizing energy required.
CARR
Healthy, Safe and Sustainable Buildings - one-stop-shop provider, obtained independent validation through rigorous testing process that Infinity air purifier's Capture & Kill technology inactivates 99% of COVID-19 trapped on the filter, the first of its kind. Orders for those filtration systems were up 140% y/y in 3Q. They also have orders for ~15,000 OptiClean units and active pipeline for thousands more. Through relationship with Cushman & Wakefield, they upgraded Denver area office campus with air purification systems with needlepoint bipolar ionization technology for every rooftop unit on its campus, along with service by Carrier's BluEdge platform. They signed an HVAC deal at the 50-floor One Court Square Tower in Long Island City, which they estimate will save up to 20% in energy cost annually, and deliver improved comfort and air quality. For the healthy building space overall, they now have an active pipeline of potential order activity of \$150 million and they are still in the early stages of putting the comprehensive strategy. The orders of \$150mm are not all firm yet – includes OptiClean, Cushman & Wakefield, UV lights & bipolar ionization, other filtration additions. IAQ - very encouraged by trends, but opportunity. People spend 90% of their time indoors. Indoor square footage is going to double over the next 40 years. They have introduced new products, like OptiClean, the certification of our electrostatic filters for the home. They are working on air purifiers, new types of filtration (UV or bipolar ionization), and see significant pull. They also look at broader ventilation solutions about air flow and air changes per hour that are more holistic changes, and will ultimately work on a digital solution. So, tenants have visibility to whether or not the indoor air environment is up to standard, which they will roll out holistically. Additional opportunity created through IAQ is about 10% of total market (\$90B-100B) i.e. \$9B-\$10B. They are confident to get more than fair share of that. In Southeast Asia, they had a very significant dedicated IAQ sale. The Blue Diamond is going to be part of overall digital solution because that can have customer intimacy where you can look at your smartphone and you can use that to see how are the actual indicators for IAQ.
TI
They estimate that there is 1.7 trillion square feet of non-residential building space in the world. Over 400 billion square feet of this represents non-residential communal space. People spend on average of 90% of the day indoors, which reinforces the need for healthy indoor environments. Building owners, tenants and every occupant of an indoor space are looking at the overall health of the physical environment with a new sense of responsibility and concern, and contemplating to renew or bring indoor spaces to better overall air quality standards. HVAC systems already drive >40% of a building's total electricity demand. Many IAQ strategies and enhancements can have a negative impact of further increasing building electrical demand by 15% to 40%. So they helped raise overall IAQ of spaces through implementation of more efficient systems, controls and broad-based energy conservation measures. They are seeing solid activity for more modest-sized projects aimed at immediately addressing the most pressing challenges for reopening buildings. They believe IAQ represents a long-term secular tailwind. They launched a center for healthy and efficient spaces during the quarter, to drive strategy and innovation. Building availability is still a headwind, IAQ is certainly a tailwind. But net is a positive set up for the service business. Service business was a great antidote to a recession, but if access to buildings is denied, it's tough to grow service business, but they are busy on the IAQ front and as buildings continue to open, there'll be some deferred service, deferred maintenance that they expect there as well. Management believes that urgency for IAQ enhancements may come from changes in regulations and building codes as standard setters may require more air changes per hour in the future. They continue to see strong customer demand and momentum in indoor air quality, number one and are taking a systems approach. They are looking at opportunities to improve IAQ, on the filtration side, on the fresh air exchange side, sensors to improve the humidity levels, temperature, occupancy. If they wanted to increase the fresh air exchanges to a greater degree, they may need additional cooling capacity. Energy projects can reduce the tax on the building to bring IAQ up. They are taking modest projects to make buildings as healthy as they can get with current set of assets today, and then they will give that roadmap for the future job. They believe that, initially, particularly in the developed economies, there will be an immediate look back to looking at buildings and whether or not they're operating at standards, and then what you do to mitigate that.

LII

LII claims they have an industry leading IAQ offering just like their competitors in the space. The Pure Air S is a residential system with a filter that removes from the air over 99% of the virus that causes COVID-19 based on independent third-party testing, while also having a full line of residential IAQ products, including UV lights, humidity control and outdoor air ventilation. On the commercial side, they plan to launch a new premium rooftop line the Model L with an advanced IAQ package that can allow building owners to purify air, ventilate and control humidity better.

In October, Lennox Commercial introduced the Building Better Air initiative, which helps facilities evaluate the state of their HVAC systems by using IAQ surveying and create solutions tailored to the needs of the building. We have a full product lineup of high-efficiency filters, UV lights, bipolar ionization, energy recovery and dedicated outdoor units and humidity control. We work with our unitary commercial customers to meet their IAQ needs.

On its most recent conference call management cited \$100mm in residential IAQ sales (~LSD% of sales) and it touted an industry leading offering although the commentary came off as suggesting changes would be incremental, not a driver to material upside.

According to management, however, only 25% of new replacement systems have attachment of IAQ-related products, and with 50% of the industry at entry level that represents somewhat of a ceiling. IAQ enhancements typically drive up price 10 points.

Lennox estimates the total HVAC market for residential in NA around \$13B-\$14B and total HVAC market for commercial around \$12B, so assuming IAQ drives price up 10 points the market is assumed to be \$2B-\$3B in NA.

Source: Company reports.

Biden Plan Looks Positive For Building Investment, But the Term "Upgrade" Is Understandably Vague

The Biden campaign has presented a plan to "Upgrade 4 million buildings over 4 years" as well as to "spur the building retrofit and efficient-appliance manufacturing supply chain by funding direct cash rebates and low-cost financing to upgrade."

Interestingly in the plan, Biden's team specifically called out the desire to "improve indoor air quality and indoor environmental health, thus making our buildings safer in the face of future pandemics." This includes mobilizing a trained and skilled American workforce to manufacture, install, service and maintain high-efficiency LED lighting, electric appliances, and advanced heating and cooling systems that run cleaner and are less costly – all manufactured in the United States. Biden will also repair the building code process with the goal of establishing building performance standards for existing buildings nationwide and support this effort with new funding mechanisms for states, cities, and tribes to adopt strict building codes and labor standards to ensure quality and predictability. Paired with legislation to set a new net-zero emissions standard for all new commercial buildings by 2030, these steps and critical investments in the Build Back Better Plan will accelerate progress to Joe Biden's target of cutting the carbon footprint of US national building stock in half by 2035.

To put into perspective, 4 mm buildings is a large number in the context of the 5.6 mm buildings that make up the US stock, and compares to ~15,000 chillers shipped annually and 310,000 commercial unitary products (defined as over 65 BTUs). To provide some perspective around HVAC, more than 50% of those volumes annually are replacement, putting some further context around what 4 mm buildings mean. The march for more energy efficient commercial buildings through codes and utility rebates has been on for some time, and LEED certified/green buildings continue to grow, though they represent a small percentage of the total commercial stock by number at <100,000 out of the 5.6 mm+ commercial buildings.

For CBRE, in their "Green Building Adoption Index," they include buildings that are either LEED certified or EnergyStar. Their data shows that shows that ~14% of all commercial office buildings across the 30 largest US office markets are "green certified" in some capacity. This is the highest in the history of the index and breaks down with ~12% EnergyStar Certified and ~5% LEED Certified for all commercial buildings. From a floor space perspective, the numbers are ~36%, and ~21%. The point is that there is currently a relatively low penetration with a lot of room to run for Biden's plan, but also that there has been a trend in place already. In addition, a target to make 4 mm buildings "efficient" would seemingly include many small/mid-size buildings. Indeed, from the 14% of office buildings defined as "green" by

CBRE, the floor space represented is just over 40%, evidence that the drive from larger buildings is already well underway.

Figure 232: Green Certified Commercial Buildings in the US
30 LARGEST U.S. OFFICE MARKETS



Source: CBRE 2019 Green Building Adoption Index Report

However, the term “upgrade” is vague and without details on the magnitude of the incentives, measuring the types of upgrades that qualify is of critical importance. Does an upgrade need to entail an overhaul of the HVAC system, or simply mean LED lighting, replacing windows and better insulation? Does the “upgrade” need to meet EnergyStar or LEED minimum standards or can it be a self-regulated upgrade? In looking for answers to these questions, data seems to point to a relatively low bar for upgrading buildings. Historical guidance from EnergyStar suggests several ways to “upgrade” the buildings including first lighting, then supplemental load reductions (such as improving electric loads and equipment upgrades), then air distribution systems improvements and then finally working within the existing HVAC system. For LEED certification, while there are different tiers, the minimum certification is 40 “points,” with Platinum certification 80+ points, which are earned based on

criteria such as location and transportation, water efficiency, materials and resources used, etc. The full list seen below provides evidence of how vague the standard is.

Table 98: LEED Certification Categories

Category	Description
Location and Transportation	How do people get to, and enter/exist the facility
Materials and Resources	Earn credits by using earth-friendly products, reducing waste, and promoting better indoor air quality
Water Efficiency	Potable water usage is reduced and resources can be reused
Energy and Atmosphere	Building must enhance energy performance and promote indoor air quality
Sustainable Sites	Design of building must promote the natural resources and ecosystems nearby and naturally minimize environmental pollution
Indoor Air Quality	Increase daylight usage and promote natural ventilation

Source: LEED

In other words, there are many ways to upgrade outside of the expensive proposition of replacing the entire HVAC system, the biggest ticket and highest first cost option, and while there may be some that pull forward that decision, it will still be an economic one. In the near term, with Biden winning the election, we expect a pause as those that do have projects in the pipeline likely take a wait and see around what types of incentives they can take advantage, with no material change to the ultimate activity. In the end, we think the cycle will be the cycle with a solid 10%+ upturn following whatever downturn we see near term.

Money Where Their Mouth Is: ESG Becoming A Driving Force For Capex

We view ESG investments as a key driving factor to watch. While the impact from the “E” aspect of ESG has been generally negative for the EE/MI sector given the decline in oil/gas activity, there are other parts of the economy that are seeing lift on many fronts, and we are watching various company-generated reports for clues as to how sustainable this spending is. To start, as part of the conversation around sustainability efforts and increased focus on improving building efficiency, we look to Amazon as a proxy for many large, dominant companies with a significant buildings footprint, be it from ecommerce warehouses or datacenters. Amazon’s Climate Pledge is to reach net zero carbon by 2040, with part of this being an investment into their sustainable buildings plan. The highlight here is that the company has stated that they will pursue third-party (i.e., LEED) certifications for their buildings, with 30 already LEED certified (majority Gold or Platinum level). Additionally, the HQ2 being built in Arlington, VA with a 2022 completion target will use 100% renewable energy. Below we look at the extent of Amazon’s Climate Pledge and we expect to see more companies in more industries follow suit as environmental regulation becomes stricter and general interest in renewables and building safety and sustainability increases.

Table 99: Amazon Climate Pledge Highlights

Category	Program Detail
Renewable energy	Power operations with 100% renewable energy by 2025 In 2019 reached 42% renewable energy across the business. As of June 2020: 91 solar and wind projects to generate 2900 megawatts and more than 7.6 million megawatt hours of energy annually March announced four new renewable energy projects in Australia, Sweden, Spain and the US. 300MW and 840,00 MWh of energy annually Transitioning buildings to be net zero carbon with improvements on water and waste reduction strategies
Sustainable Buildings	Pursue third-party building certifications. Has 30 LEED certified buildings in the US (majority Gold and Platinum level) and 20 BREEAM certified buildings in EU. HQ2 in Arlington will use 100% renewable energy (completion 2022) and constructing a new solar farm in Pittsylvania County to power HQ2 and fulfillment centers in the area
Shipment Zero	All shipments net zero carbon by 2040, 50% by 2030 Fulfillment facilities: Fulfillment centers will be 100% clean energy from wind and solar projects. More than 60 Amazon facilities already have 80% power generation from on-site solar panels
Electric Vehicles	Purchasing 100,000 electric delivery vehicles (largest order ever) 10,000 on the road by 2022 and all 100,000 on the road by 2030
Climate Fund	Investing 2B to support development of technologies and services to decarbonize Invest in companies in multiple industries with a focus on: transportation and logistics, energy generation, storage and utilization, manufacturing and materials

More broadly, looking at the top 20 companies in the S&P, sustainability reports focus on carbon emission reduction, powering of operations with renewable energy, and building energy efficiency upgrades for most of them. We show below a summary of their ESG strategies, with a focus on where the investments are targeted. While it's unclear what the budgets and magnitude of the investments will shape out to be on this front, with ESG reports only giving sparse amounts of information, investments seem largely focused on renewable energy projects and procurement for use in operations, carbon removal solutions, electric vehicles and related infrastructure, and building energy efficiency. On the latter, this includes replacing outdated HVAC/lighting systems for higher efficiency systems, expanding the use of building controls, building management systems and smart building solutions, to reduce emissions and improve the efficiency of energy use, in the pursuit of green building certifications. We also highlight other investments in reforestation projects, waste reduction, water efficiency, recycling infrastructure and digital infrastructure for sustainable manufacturing as other recurring themes, which we don't show below. In other words, there is real and tangible investment behind these ideas and trends and we view spending on ESG related activity as sustainable, a boost to what we have always argued around energy efficiency in buildings being a long-term driven in commercial HVAC. We delve into this next.

Table 100: Top 10 Companies' ESG Strategies

	% renewable energy in operations	Carbon neutral	Emissions reduction	Investments in renewable energy	Investments in building/energy efficiency	Investments in EVs	Investments in carbon reduction/removal	Building energy efficiency upgrades
Apple	100%	By 2030	-75%	Long-term power purchase agreements in solar PV/wind projects; \$300mm in China Clean Energy Fund.	\$100mm in accelerated energy efficiency projects for Apple's suppliers		Carbon-removal solutions; \$144mm into the development of a carbon-free aluminum smelting process	Replace outdated or inefficient HVAC/lighting systems, repair compressed air leaks, recover waste heat.
Amazon	42% (target 80% by 2024, 100% by 2025)	By 2040				100,000 electric delivery vehicles from Rivian (start delivering in 2021, 10,000 vehicles on the road by 2022)	\$2B into the Climate Pledge Fund to support companies developing decarbonization solutions	Retrofit buildings, expand use of building control system technology, use motors and advanced controls in conveyor systems
Microsoft	100% by 2025 (datacenters at 60% today)	Carbon negative by 2030	-50%+ by 2030.	Power purchase agreements for green energy; move towards low-carbon fuel sources and advance battery technology		Electrify operations vehicle fleet by 2030	Remove all the carbon it has emitted by 2050; \$1B invested over 4 years into carbon reduction/removal technologies	Partnerships to address carbon reduction, like with ABB and JCI on sustainable smart building solutions.
Google	100% since 2017	Since 2007		Contracts to purchase output from renewable energy projects; buy wind/solar electricity for every unit of electricity they consume				Pursue healthy-building certifications, smart temperature and lighting controls, advanced cooling techniques, etc.
Facebook	100% by 2020-end (86% in 2019)		-75% vs 2017 (-59% in 2019)	Direct investments in renewable energy projects, and contracts in partnership with local utility providers				Data centers are contracted for 100% renewable energy
Berkshire Hathaway				Invest in wind, solar, geothermal and biomass generating facilities; \$6B through 2021 on construction/repowering of wind facilities				
Johnson & Johnson	100% by 2050, 35% by 2020		Vs 2010, -32% by 2020, -80% by 2050	Wind turbines, power purchase agreements of renewable energy, wind mills, geothermal energy wells	Capex on energy efficiency up to \$40mm per year; target LEED certification for all new buildings, and renovations of >\$5mm	Charging stations for electric cars		Replacements of chillers and cooling towers, reduced airflow of cleanrooms in air handling units.
Visa	100%			Purchasing renewable energy sources (wind, solar) through utilities and attribute certificates				Building management systems, efficient lighting and controls, HVAC upgrades and data center infrastructure improvements
Walmart	100% by 2035 (vs 28% in 2019)		Zero emissions by 2040	Harvest wind, solar and other renewable energy		Electrify and zero out emissions from all its vehicles, including long-haul trucks by 2040		Improve energy efficiency and refrigeration systems; reduce total kWh-per-square-foot energy intensity powering their buildings by 20% vs 2010 (-13% in 2019); transition to low-impact refrigerants for cooling and electrified equipment for heating by 2040.
Procter & Gamble	100% by 2030	2020-2030	-50% by 2030				Fund projects to protect lands that increase carbon storage or avoid emission	

Source: Company reports.

Table 101: Top 10-20 Companies' ESG Strategies

	% renewable energy in ops	Carbon neutral	Emissions reduction	Investments in renewable energy	Investments in building/energy efficiency	Investments in EVs	Building energy efficiency upgrades
MasterCard	100%	Target zero carbon emissions	-38% by 2025 vs 2016 for Scope 1/2 (achieved -43%), -20% for Scope 3 (achieved -40%)	Lessen dependence on unbundled renewable energy credits by investing in new renewable projects. Expanding onsite solar footprint at data centers.		Encourage employees to use EVs with preferential parking and free charging	All owned campuses/data centers are certified LEED, 85% workspace meets green certification standards. Sustainability built into new construction from the start (renewable energy, water efficiency). Retrofitting older buildings (installed sub-metering tech, advanced lighting controls).
Nvidia	65% by 2025 (34% currently)		-25% by 2025 (vs 2019)	Evaluating opportunities for onsite solar photovoltaic generation.		Offer EV charging (have 39 charging stations)	Incorporating considerations around energy efficiency and renewable power options as grow their footprint. Deployed cooling tech, controllable LED lighting.
JPMorgan Chase	100% by 2020			Installing on-site renewable energy at retail branches and comm'l buildings, power purchase agreements for new renewable energy projects, and RECs. Restricting financing of coal and new oil/gas development in the Arctic. \$50B investment in "green initiatives" for climate action, clean water and waste management through 2017-2020.			LED lighting retrofits, energy-efficient building management systems.
Home Depot			-39.9% by 2030, -50.4% by 2035 vs 2018, -20% energy use by 2020 vs 2010 (achieved 23.5%)	Produce/procure 335MW of renewable/alternative energy by 2025 (vs 131MW in 2018), including off-site solar and wind and fuel cells.			Installation of LED lighting fixtures, energy-efficient HVAC systems, upgraded building automation systems, on-site batteries to store electricity (installing more in 2020)
UnitedHealth Group			-3% by 2023 (vs 2017)	Purchasing renewable energy supply contracts, offsetting 100% of Scope 2 emissions	Investing annually in energy efficiency projects to reduce carbon emissions		Implement green building construction practices. Sustainability projects include lighting upgrades and water reduction. Target 75% minimum of square footage meets LEED guidelines for indoor water efficiency by 2020.
Verizon Communications	50% by 2025	By 2035	Carbon intensity -50% vs 2016 (achieved in 2019)	Purchasing renewable/clean energy and carbon offsets. Investing \$143.23mm of the \$1B green bond in renewable energy. Adding 24MW on-site green energy by 2025.	Investing \$319.34mm of the \$1B green bond in green buildings, and \$36.65mm in energy efficiency		Focus on ENERGY STAR-certified buildings, onsite renewable energy installations, and energy-efficient systems.
Disney		Net zero emissions long-term	-50% by 2020 vs 2012	Continued investments in renewable and lower carbon energy. Brought online a 50+ MW solar facility.			Aim for LEED Platinum for its NYC campus. Projects include HVAC upgrades and lighting efficiencies.
Adobe	100% by 2035		80% vs 2018, and -100% by 2050	Invest in on-site renewable energy, renewable energy instruments, CCEs, PPAs and green tariffs. Target 100% renewable without purchasing unbundled credits or carbon offsets.			Electrification of older buildings, and improved energy efficiency (lighting, HVAC upgrades/replacements to BMS controls refinements
salesforce.com	100% by 2022		-50% by 2030 (vs 2018)	Large-scale, long-term purchases that add renewable to the grid, PPAs, high-quality carbon credits/offset projects			Prioritize green-certified buildings, negotiate green lease terms for new and existing buildings. Focus on LED lighting, occupancy sensors, floor-level submetering.
Bank of America	100%	Since 2019	-50% from 2010-2020	Raised 5 green bonds totaling \$6.35B for renewable energy projects since 2013. Purchase RECs and carbon credits, on-site solar, long-term renewable agreements for new wind/solar. Offer employees discounts on solar panel installation.	Deploy \$300B in 2020-2030 (deployed \$145B since 2007), toward renewable energy, energy efficiency, sustainable transportation...	Installed >100 EV charging stations, offer employee discounts on home EV chargers.	

Source: Company reports

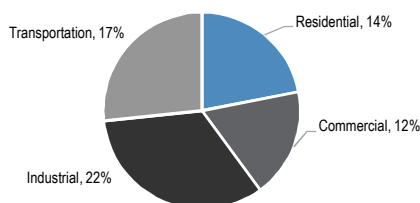
Energy Efficiency Remains a Key Long-Term Commercial Driver

HVAC systems represent 30-50% of commercial building energy use globally, making energy efficiency a key aspect of any long-term view on the commercial industry. Like other capital goods, energy savings are not a bulletproof driver through a recession but rather a key to encouraging the ongoing replacement of older, less efficient units. Unlike residential, the paybacks on early commercial replacement are relatively more attractive, with less dramatic first-cost hurdles, particularly for ROI-focused corporate customers that have cash. Longer term, we think HVAC fits well into the theme of growing energy-efficiency awareness, both at the corporate and government levels.

HVAC a major source of global energy use

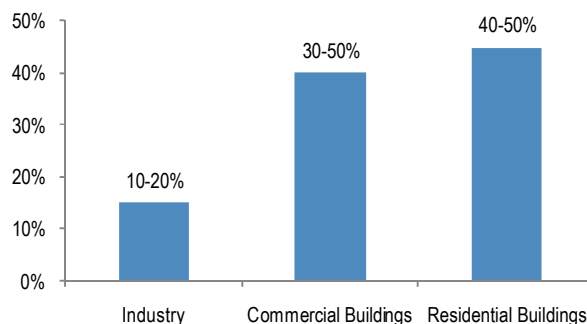
We estimate that HVAC is the single building product that uses the most energy, accounting for 15-25% of *total* US energy consumption, according to the DOE. Within the HVAC sector, residential applications consume slightly more (as a percentage of total energy use) than commercial ones, though both are close to 50%. The balance is attributed to industrial applications. Frost & Sullivan estimate that HVAC systems in commercial buildings account for >40% of total energy use.

Figure 233: 2020 US Energy Consumption



Source: EIA, Data from Jan-Nov 2020

Figure 234: Energy Consumption by HVAC as % of Total Sector

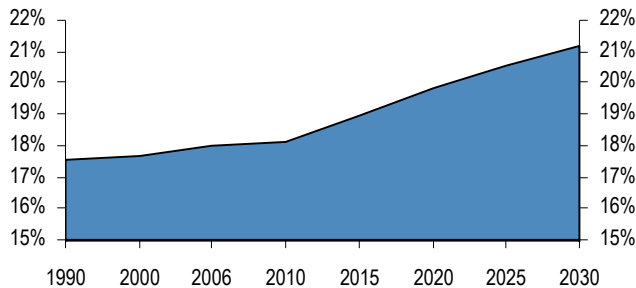


Source: DOE.

From a longer-term perspective, commercial buildings are expected to be the fastest growing sources of energy use, according to DOE forecasts, going to over 21% of the US total by 2030. Including residential use, the DOE expects buildings to account for over 42% of all US energy consumption. These dynamics should be even more pronounced in emerging economies like China and India. All in, the International Energy Agency (IEA) estimates that energy demand for buildings will stimulate half of energy supply investments between now and 2030. In its 2019 annual energy outlook, the IEA said it expects energy consumption and generation in resi and commercial buildings to grow through 2050, with increasing demand for electricity and natural gas, partially offset by advances in energy efficiency.

Figure 235: Commercial Buildings as % of Total US Energy Use

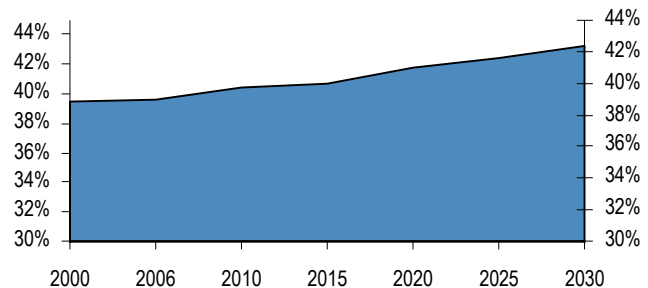
DOE Forecasts



Source: DOE

Figure 236: Total Residential/Commercial Building Energy

DOE Forecasts, % of Total US Energy Use



Source: DOE

Paybacks on commercial replacements are relatively attractive . . .

Paybacks don't make the market "bulletproof" through a recession, but the replacement of old HVAC systems will be an attractive investment in normal economic times.

Unlike residential, where the payback of an early replacement rarely makes sense, the economics on the commercial side are somewhat better. OEMs have estimated the typical payback on a chiller replacement at anywhere from 2 to 10 years versus an average life of the equipment of 20-25 years. Not surprisingly, this will be highly dependent on the age of the installed chiller as older equipment will be less efficient and make the payback on a new machine more attractive. For this reason, energy-efficiency gains will often motivate customers to replace systems that are functioning well but are nearing the end of their useful life, a catalyst for replacement.

. . . but right on the edge of what building owners see as attractive

In the end, most commercial HVAC replacement is cyclical, and energy-efficiency spending will look more attractive in a good economy.

How do these paybacks compare to what customers are targeting? Most surveys of facility managers have shown the median payback hurdle to be in the ~3-4 year range, though this will vary significantly depending on the circumstances. This means that the payback economics of HVAC replacement are often right on the edge of what a building owner deems attractive. Early replacement can be pitched as an attractive investment, but equipment manufacturers often have to fight customers' resistance to replacing an old system that otherwise seems to be operating fine. As background, while there are other sources of funding for these types of improvements, most efficiency upgrades will be spent directly out of the facility capex budget, making payback periods key.

Table 102: Chiller Payback Analysis

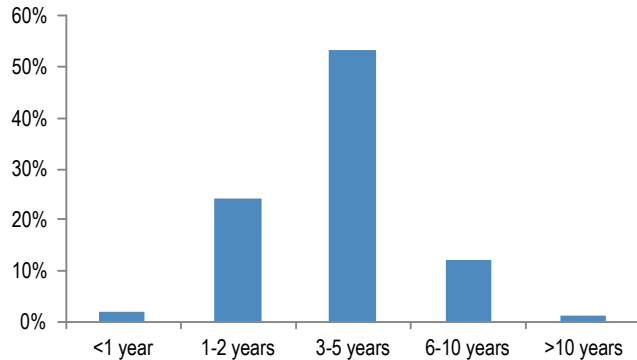
	Old Chiller	New Chiller with Oil	Oil Free Chiller
Tons	700	700	700
\$/kWh	\$0.10	\$0.10	\$0.10
Annual Energy Cost	\$165,000	\$75,000	\$60,500
Annual Oil Changes	\$5,000	\$5,000	\$0
Annual Operating Cost	\$170,000	\$80,000	\$60,500
Investment		\$175,000	\$210,000
Payback to Old Chiller		1.94	1.92
Payback for Oil Free versus New Chiller			1.80

Source: J.P. Morgan estimates

Note: Payback = Incremental Investment / Difference in Annual Operating Cost

Figure 237: What Is Considered an Acceptable Payback Period for Projects Related to Sustainability?

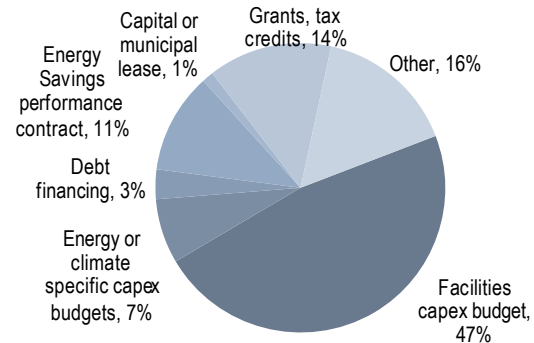
% of responses



Source: IFMA

Figure 238: Energy Efficiency Spending Source

% of funding

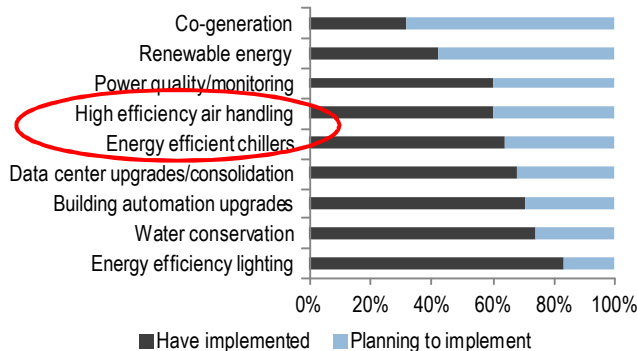


Source: IFMA

For efficiency spending, HVAC near the top of the list

Where does HVAC stand relative to other sustainability or energy-efficiency investments a commercial building owner can make? We believe lighting retrofits have been the most commonly implemented measures, a function of the attractive paybacks and the relative ease of installation. Meanwhile, the use of on-site renewable or cogeneration has been growing but remains somewhat of a niche product. Our sense is that HVAC sits somewhere between these two extremes, a product that is frequently targeted in energy-efficiency investments but requires more upfront investment than smaller, modular projects like lighting upgrades. Recall, however, that core heating and cooling functions takes up ~25% of building energy use, more than the energy consumed by lighting.

Figure 239: Which of the Following Energy Efficient Systems/Equipment Have You Implemented or Are Planning to Implement Within the Next 1-3 Years?



Source: IFMA

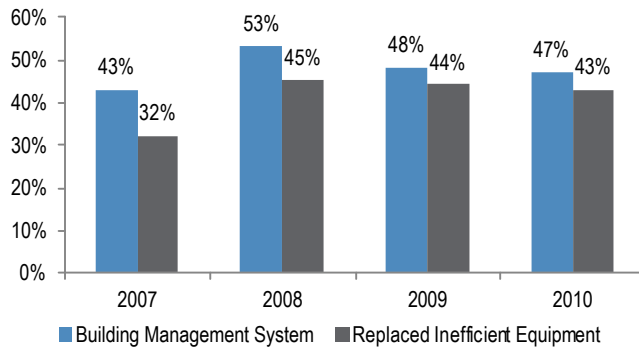
Table 103: What Sustainable Practices Have You Developed with Regard to Energy Use?

Retrofitted or upgraded lighting	75%
Adjusted HVAC operating hours	74%
Upgraded/improved building management system	63%
Installed lighting sensors	57%
Replaced equipment with newer, efficient models	43%
Increased energy consumption monitoring	40%
Renegotiated with energy suppliers	40%
Participated in demand response programs	19%
Installed energy saving glass, reflective roof	17%
Solar, wind, or alternative energy sources	11%
None	4%

Source: IFMA

Figure 240: Have You Replaced Inefficient HVAC Equipment Before the End of Its Useful Life? Upgraded Building Management Systems?

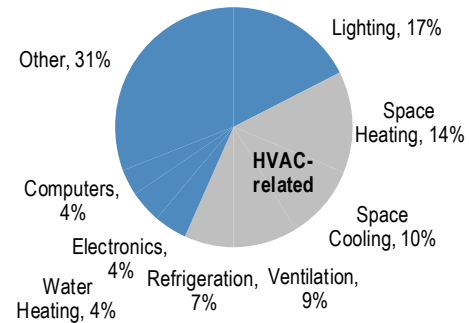
Percent responding 'yes'



Source: IFMA

Figure 241: Commercial Buildings Energy Use by Function

%



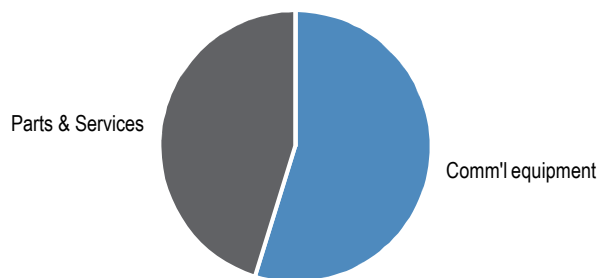
Source: DOE

Services are a growing piece of the commercial end-to-end solution.

Most of the major industry players are increasing their focus on the services and longer-term contracting portion of their business as they look to (a) build a base of recurring revenues and (b) provide their customers with end-to-end support around their equipment purchases. Trane has noted how \$1 in equipment sales equates to \$4 in services and \$4 in enhancements, upgrades, and add-on sales over an average 20-year period.

Figure 242: Trane Commercial Segment Sales Breakout

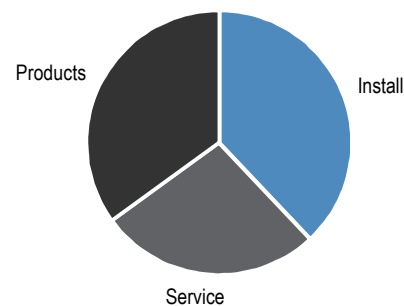
% of commercial HVAC revenues



Source: Company reports, J.P. Morgan Estimates

Figure 243: JCI Buildings Segment Sales Breakout

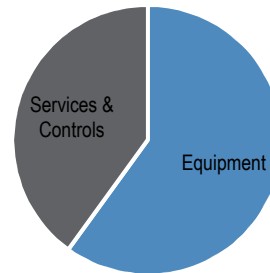
% of total revenues



Source: Company reports

Figure 244: Carrier Commercial HVAC Sales Breakout

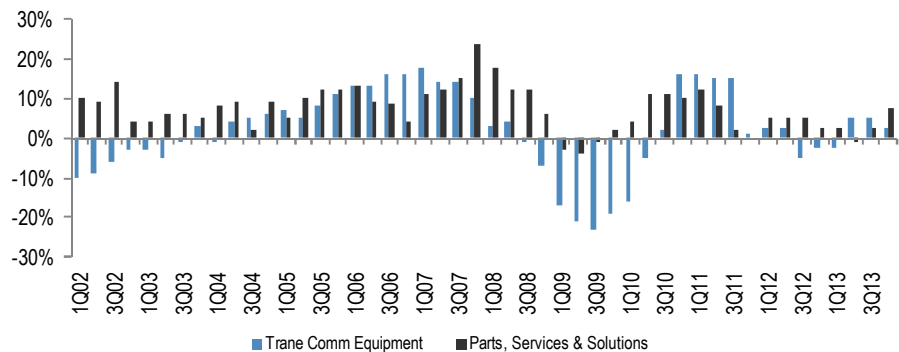
% of commercial HVAC sales



Source: Company reports, and J.P. Morgan estimates.

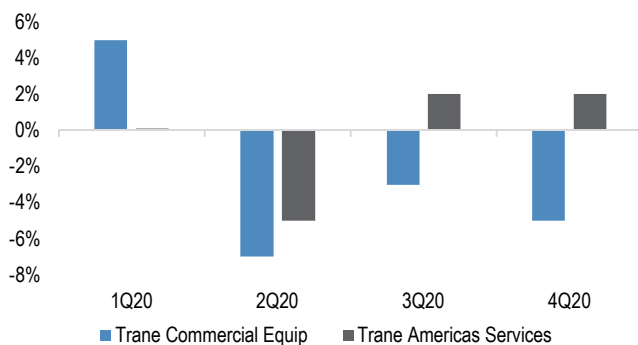
Generally speaking, commercial services revenues are less cyclical than equipment sales as they are more equivalent to MRO-related spending. Even through the depths of the 2009 downturn, Trane saw only low-single-digit declines in its aftermarket sales, evidence of the stability of these revenues once the installed base has been won.

Figure 245: For Trane, Commercial Services Have Historically Been Less Cyclical



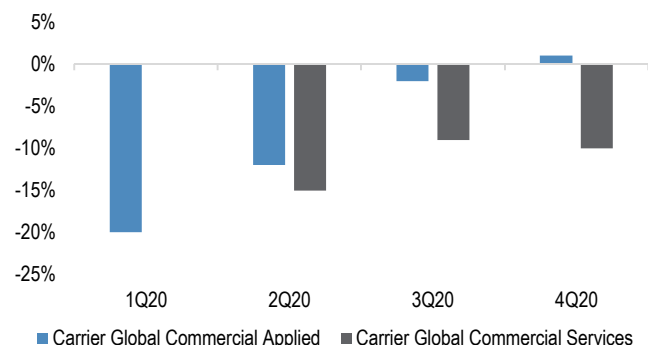
Source: Company reports.

Figure 246: Trane Commercial Services Outperformed Equipment During COVID-19 Downturn



Source: Company reports, and J.P. Morgan estimates.

Figure 247: Carrier Commercial Services Declines Were About In Line With Equipment



Source: Company reports, and J.P. Morgan estimates.

Controls also key

Controls are key in managing systems in buildings on a continuous basis, and with increasing regulations around energy use and consumption, these become key as customers look for optimization around energy efficiency and cost savings. Trane's control solutions directly address global mega trends around sustainability, reduced greenhouse emissions and energy intensity, for which they are providing more sophisticated equipment linked to service and controls, with diagnostics and analytics important in managing the system in its lifetime. Controls enable them to model different systems and outcomes, and are now ubiquitous at this stage according to them, with about 100% attachment rate of diagnostics on equipment produced today. They expect to monetize and utilize those data analytics and diagnostics going forward, and see opportunity in improving business models by investing in analytics. In a downturn, they think mission-critical facilities would still need to be maintained, or replaced with more expensive and efficient, and lower gas emitting products and systems, in which Trane integrates controls, and the tailwind from regulations around efficiency and greenhouse gas emissions should support growth no matter what the macro environment looks like. Additionally, the presence of building controls can offer customers significant energy cost savings, and Trane cited 30-50%.

In the current environment, controls are becoming increasingly important, with IAQ concerns and a push for more remote monitoring. JCI unveiled its OpenBlue system which houses its integrated IAQ and efficiency products and controls while other companies stress the importance of remote monitoring and the increased customer interest in those types of products.

Service attachment is crucial for commercial HVAC profitability and each OEM is trying to increase attachment rates. CARR ended 2020 with 30% attachment with a goal to reach 50% in the next few years. TT has 100% attachment on applied systems and believes that OEMs are entitled to their aftermarket service revenue stream. While JCI noted that attach rates are currently underserved at roughly mid-30s with the goal to grow it 300-400bps in 2021. The general consensus is to grow attachment rates through connectivity and digital offerings. Historically the strategy was to grow the installed base, however now with technological advances they can start connecting systems and create more demand for service offerings.

Commercial HVAC Industry Landscape

This section provides an overview of industry structure and market share of key OEMs across various segments. As background, there are two major product types of commercial equipment: larger applied systems and smaller unitary systems. We estimate that the total global commercial HVAC equipment market is ~\$40B (30% of total global HVAC sales), with applied systems market ~40%, ductless around 45%, and unitary ~15%. The three major players are Trane (estimated 40% share in NA applied, ~25% in NA unitary), Carrier (estimated similar share in commercial unitary, with less share in larger applied), and JCI (~25% share in smaller applied, ~45% share in larger applied, minimal share in unitary), as well as LII (but only Unitary, an estimated 10-15% share in NA).

Table 104: Commercial HVAC Growth Rates

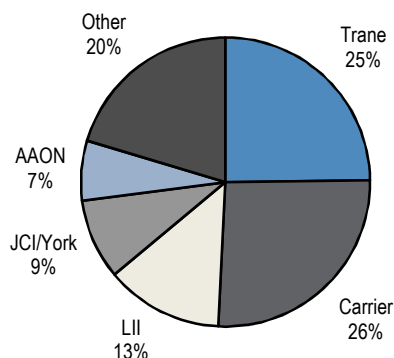
	2017				2018				2019				2020			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Trane Comml Equipment	7%	6%	4%	6%	13%	10%	8%	6%	10%	7%	5%	8%	-3%	-9%	-3%	-9%
Goodman Comml HVAC	4%	12%	14%	25%	17%	18%	18%	10%	20%	7%	18%	28%	21%	7%	3%	-4%
LII Comml HVAC	9%	3%	6%	6%	3%	12%	2%	9%	-3%	4%	7%	12%	3%	-28%	-18%	-13%
Carrier Comml HVAC	5%	3%	5%	5%	5%	3%	8%	6%	2%	4%	2%	3%	-8%	-17%	-7%	-5%
AAON	1%	-1%	9%	14%	15%	8%	-1%	8%	15%	9%	1%	9%	21%	5%	19%	NA
Trane Comml Equip Orders	8%	-3%	5%	9%	9%	15%	12%	20%	7%	9%	7%	5%	8%	-7%	-1%	-1%
Carrier Comml Equip Orders	5%	5%	7%	20%	3%	6%	2%	6%	-2%	-2%	6%	2%	-11%	-15%	0%	0%
JCI BE Orders	2%	1%	2%	3%	7%	8%	9%	7%	2%	6%	5%	0%	-7%	-16%	-7%	-3%

Source: Company reports. Note: NA = not available.

Commercial Unitary Landscape

Commercial unitary equipment is essentially a large residential unit, consisting of a condensing unit (compressor and condenser) and an evaporator coil, with a price range estimated at \$1,500-30,000 and an average of ~\$5,500, according to Frost and Sullivan. We estimate the U.S.-centric light commercial HVAC equipment market, or “commercial unitary,” at ~\$6 billion, or ~5% of industry revenues, with the North America market at ~\$5B. The top manufacturers in the NA commercial unitary equipment space include Carrier, Trane, and LII, as well as York and AAON, which collectively make up an estimated ~80% of the industry, by our estimates. Frost and Sullivan estimates that there are probably 40-60 tier-two competitors, including AAON and York, with a big portion of this business going to higher-cost, custom applications. While estimates of share vary, we estimate that Carrier and Trane are the leaders in commercial unitary, followed by LII. Among the top players, LII has traditionally been more focused on direct sales to national accounts, while Carrier/Trane have had a more mixed model, which includes a bigger presence in emergency replacement, though Lennox has recently been making a strong push into the emergency replacement space.

Figure 248: North America Light Commercial Market Share (~\$5B)



Source: J.P. Morgan estimates.

Large Commercial HVAC Equipment Landscape

We estimate that the large commercial HVAC equipment market is ~\$16B, or ~10% of industry revenues. This represents all chillers sold as well as the related applied equipment such as air handler and fan coils. According to Frost and Sullivan, these systems come in a price range of \$30,000-250,000, with an average cost of ~\$100,000. Commercial applied equipment is built to order and consists of components such as a chiller, condenser, evaporator, and compressor, along with

controls and motors for a multi-zone cooling application. While this market segment is often referred to generically as “chillers” (the key cooling unit that is provided by the major OEMs like Trane/Carrier), keep in mind this is only one of the components of a large cooling system. The table below provides examples of the major products that go into an applied system, many of which are provided by the HVAC OEMs but some (i.e., cooling towers, pumps) that are not.

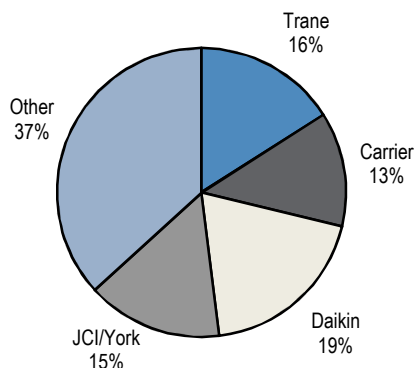
Table 105: Common Applied Equipment Products and Competitors

Product	Major Companies	Market Size
Air Handling Units	Trane York Carrier McQuay Dunham Bush	~2,000
Central System Terminal Boxes	Titus Trane ETI	~375
Fan Coil Units	IEC Trane McQuay	~250
Classroom Unit Ventilation	Trane McQuay	~325
Cooling Towers	Baltimore Air Coil Marley Evapco	~1,100
Pumps	Taco Bell & Gosset Paco	~650

Source: DOE estimates

The key manufacturers in the larger commercial equipment space include Carrier, Trane, York, and Daikin, which collectively make up an estimated ~60-65% of the industry. The top three companies own the majority of the share in the most sophisticated chiller applications, given a more engineered product that provides somewhat of a barrier to entry. The middle to lower end of the market, however, is more fragmented, particularly in regions like Asia. The commercial services market is much more fragmented, though still competitive, as the three major players, Carrier, Trane, and York, all fight for positioning to serve the large installed base and drive incremental volumes.

Figure 249: Global Large Commercial Market Share (~\$15.5B)
2018

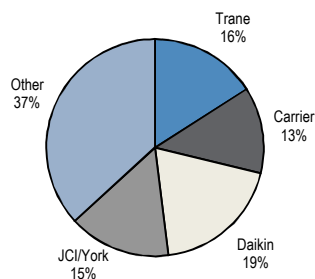


Source: J.P. Morgan estimates.

From a market share perspective, we show below global breakouts, which may differ optically from other market share numbers companies give, as the North America market appears to be more concentrated than globally, where Trane for example would stand closer to ~30-40% market share in chiller equipment vs. the share shown below. Diving into these breakouts, the top 4 players share 55-60% of the chiller market evenly, with JCI slightly ahead. By type of equipment, these players share 75% of the ~\$1.9B air cooled market, with Carrier ahead, as well as 75% of the ~\$1.9B centrifugal market, with JCI at 2x the market share of the other three. On water cooled equipment, this ~\$1.3B market looks more fragmented with JCI behind the other three at mid- to high-teens share. Lastly, in the \$1.5B mini chillers market, the four players share 40% of the market evenly, with Trane slightly behind. Below, we look at these market share dynamics and summarize the major chiller products for JCI/Trane/Carrier in various segments of the large commercial market.

Figure 250: Global Chillers Market Share

%

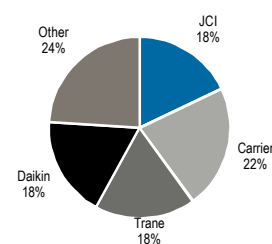


Source: Johnson Controls estimates.

Figure 251: Air Cooled Equipment Market Share (all tonnage, scroll and screw)

%

Air Cooled (all tonnage, scroll and screw)



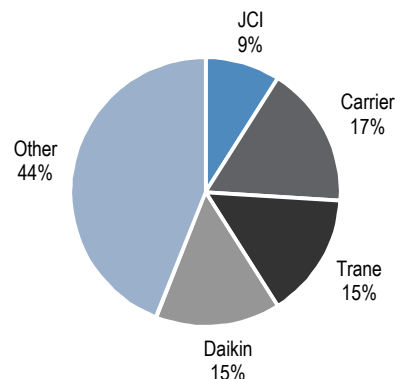
Source: Johnson Controls estimates.

Table 106: Major Air Cooled Chiller Offerings by Company

Product	Description	Compressor	Capacity (tons)	Notes
JCI York				
YCAL	Air cooled scroll chiller	Scroll	50 - 225	Self-contained unit designed for easy, low cost outdoor installation
YVFA	Free cooling VSD screw air cooled chiller	Screw	115 - 380	Low operating cost, variable speed drive compressor
YVAA	Air cooled variable speed drive screw chiller	Screw	150 - 500	Lowers energy consumption and reduces noise levels
YCIV/YCAV	Air cooled variable speed drive screw chiller	Screw	150 - 515	High efficiency and quiet operation at low first cost
CYK	Compound centrifugal chiller	Centrifugal	300 - 2500	Designed for high-head conditions to handle applications with unique differential pressure
Carrier				
AquaSnap® 30RAP	Air cooled liquid chiller with puron refrigerant	Scroll	10 - 150 Std,	All-in-one package that is easy to own and cheaper than others in class
AquaSnap® 30RB	Air cooled liquid chiller with puron refrigerant	Scroll	60 - 390 Std,	All-in-one package that is easy to own and cheaper than others in class
AquaForce® 30XA	Air cooled liquid chiller with R-134a refrigerant	Screw	80 - 500 Std,	Premium air-cooled chiller packages for contractors, consulting engineers, and building owners
AquaForce® 30XV	Air cooled liquid chiller with R-134a refrigerant	Screw	140 - 500	Can be customized to fit any building need; made for versatility and robustness
AquaForce® 30KAV	Air cooled liquid chiller with 134a and 1234ze (EU only) refrigerant	Screw	140 – 370	High efficiency and performance in a compact footprint
Trane				
CGAM	Air Cooled Scroll Chiller	Scroll	20-130	High efficiency, low sound levels and compact size, good for industrial or ice rink applications
Series RTAC	Air cooled screw chiller	Screw	120-500	Hermetic rotary refrigeration for comfort or industrial water cooling systems
Stealth RTAE	Air cooled Screw Chiller with Adaptive Frequency Drive	Screw	150-300	Part-load and full-load efficiencies with multiple sound reduction options
Sintesis RTAF	Air cooled Screw Chiller with Adaptive Frequency Drive	Screw	115-500	High part-load efficiency, multiple sound reduction options, uses LGWP refrigerants
Daikin				
Trailblazer®	Air cooled scroll chiller	Scroll	10-240	High efficiency and quiet operation. When power interrupted, RapidRestore® and Fast Loading make it ideal for data centers, healthcare facilities
Pathfinder®	Air Cooled Screw Chiller	Screw	100-565	High energy efficiency and low noise within a compact footprint

Source: Company reports

Figure 252: Water Cooled Market Share



Source: J.P. Morgan estimates

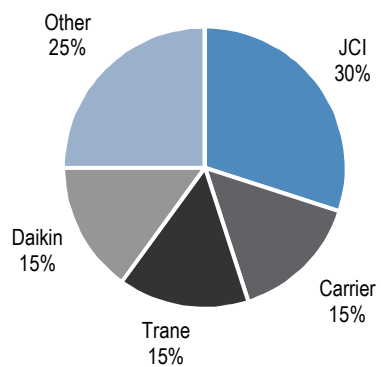
Table 107: Major Water Cooled Chiller Offerings by Company

Product	Description	Compressor	Capacity (tons)	Notes
JCI York				
YCWL	Water cooled scroll chiller	Scroll	50 - 200	Wide range of comml and industrial applications, compact with low op costs
YVWA	Water cooled variable speed screw chiller	Screw	125 - 300	Flexible configurations, reduces compressor speed to increase energy savings
YIA	Water cooled single stage absorption chiller	Absorption	120 - 1,380	Rugged industrial design ideal for applications where waste energy is produced
YZ	Water-cooled Magnetic bearing centrifugal chiller	Centrifugal	165 - 1,350	New flagship chiller, fully optimized with around the new ultra-low GWP refrigerant 1233zd and lower COO.
YMC2	Centrifugal magnetic drive chiller	Centrifugal	165 - 1,000	Features active magnetic bearing technology and reduces noise
YK	Centrifugal chiller	Centrifugal	250 - 3,000	Low COO, variable speed drive, made for schools, hospitals, high rises, DCs
CYK	Compound centrifugal chiller	Centrifugal	300 - 2500	Designed for high-head conditions to handle unique differential pressure
YST	Steam turbine centrifugal chiller	Centrifugal	700 - 2,800	Designed for large combined heating and power (CHP) plants
YD	Dual centrifugal chiller	Centrifugal	1,500 - 6,000	Compact config, variable speed drive, made for industrial or process installs
YK-EP	Centrifugal chiller w/ economizer	Centrifugal	2,500 - 3,500	Provides additional capacity through economized cycle
OM	Custom design centrifugal chiller	Centrifugal	3,000 - 5,500	For large scale cooling projects, double size of the largest packaged chiller
Carrier				
AquaSnap 30MP	Condenserless chiller	Scroll	16 - 71	Packaged liquid and condenserless chiller with compact design
16LJ	Low temp absorption chiller	Absorption	75 - 525	Large capacity comfort cooling apps like office buildings, hospitals, universities
AquaForce® 30HX	High efficiency indoor liquid screw chiller	Screw	75 - 265	High efficiency, indoor water-cooled or condenserless chillers. Compact with low vibration design.
AquaForce® 30XW	Liquid chiller with R-134a	Screw	150 - 400	Good part load efficiency and compact design, for replacement units
AquaEdge® 23XRv	Variable speed screw chiller	Screw	175 - 550	Modern, efficient chilled water plants
AquaEdge 30XWV	Water cooled liquid chiller with 134a and 1234ze (EU only) refrigerant	Screw	170-465	Good performance and value with a low GWP option
16TJ	Single effect steam fired absorption chiller	Absorption	100 - 700	Large capacity comfort cooling applications like office buildings, hospitals, universities, as well as mfg facilities and light industrial process cooling
16NK	Double effect steam fired absorption chiller	Absorption	98 - 1323	Large capacity comfort cooling applications like office buildings, hospitals, universities
AquaEdge® 19XR	High efficiency, semi-hermetic centrifugal chiller	Centrifugal	200 - 3000	Specifically for chlorine-free refrigerant
AquaEdge 19XRv	Water cooled liquid chiller with 134a and 513a refrigerant	Centrifugal	200-3500	Superior efficiencies at true operating conditions, without compromising the environment
AquaEdge® 17DA	Water cooled, custom designed centrifugal chiller	Centrifugal	3000-5500	Large tonnage applications where performance and energy efficiency vital
AquaEdge® 19DV	Water cooled liquid chiller with 1233zd refrigerant	Centrifugal	400-1000	Features ceramic bearings, a 2 stage compressor and a color touchscreen display. Better efficiency and free cooling capability at low loads.
Trane				
CenTraVac series	Water-Cooled Liquid Chiller	Centrifugal	120-4000+	Main chiller line. 9 different products across various capacity ranges.
Cold Generator series	Water-cooled Scroll chiller	Scroll	20-70	Family of 6 compact scroll chillers with applications including Education, Healthcare, Municipal, Commercial, Light Industrial
Agility series	Water-cooled Centrifugal chiller	Centrifugal		Maximize building performance with compact solution to reduce install complexity
Series R Helical Rotary Chillers	Water-cooled Rotary chiller	Rotary	80-250	Industrial-grade design for both industrial and commercial use. Includes RTWD and RTUD models.
Helical RTHD	Water-cooled Rotary chiller	Rotary	125-450	Industrial-grade design for both industrial and commercial use
Daikin				
Magnitude® Magnetic Bearing	Water-cooled Centrifugal chiller	Centrifugal	86-1600	The most comprehensive size range of oil-free magnetic bearing chillers
WSC Centrifugal	Water-cooled Centrifugal chiller	Centrifugal	300-1800	Single compressor centrifugal chillers using HFC-134a refrigerant, with smallest footprint per ton in the industry
WDC Centrifugal	Water-cooled Centrifugal chiller	Centrifugal	600-2700	Dual compressor centrifugal chillers take up less floor space than multiple single compressor chillers, while delivering the combined capacity
Navigator®	Water-cooled Screw chiller	Screw	120-300	Engineered as a fully VFD-driven platform to meet building applications that aren't suited for traditional chillers
WGZ Scroll	Water-cooled Scroll chiller	Scroll	30-200	Shipped complete, designed for easy retrofit, among quietest and most reliable chillers available

Source: Company reports

Figure 253: Centrifugal Market Share

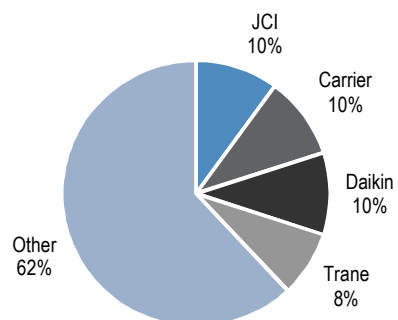
%



Source: Johnson Controls estimates.

Figure 254: Mini Chillers Market Share

%



Source: Johnson Controls estimates.

Key Sub-Markets: Latest on Compressors, VRF, and Heat Pumps

This section provides a brief update on some of the major sub-markets within HVAC. The compressor market is most relevant to Emerson within our coverage, while VRF and heat pumps are relevant to all manufacturers in the HVAC industry.

Compressors

Compressors remain a critical part of HVAC technology, but the space has been a bit less attractive over the last few years on a relative basis versus the rest of HVAC. This relates in part to market dynamics, for which the decline in countercyclical repair activity suggests that compressor revenues will continue to slightly lag that of the overall industry. Moreover, competition is intensifying as the market becomes concentrated with a few large companies after seeing M&A activity, and compressor technology levels has been raised with electronic technology, inverter control and new materials now widely applied in compressors, according in JARN. The latter also cited a trend of heat pump technology as the AC&R market has to address environmental issues, with heat pumps also promoted by some governments such as Europe and China (subsidy policy). From a competitive standpoint, the inverter compressor caused talk around the industry of the risk of vertical integration by Daikin and others, a potential negative for incumbents like Copeland. However, progress on this front by OEMs has been undoubtedly slower than initially hyped, and Copeland positioned itself well with new technologies at the middle range of the market with modulating compressors for 15-18 SEER products. True inverter technologies remain targeted at the ultra high end (18+ SEER), and traditional scroll continues to dominate the lower end (14-15 SEER). The key TBD over the next few years will be the ability for inverter technology to penetrate more mainstream products below the 18 SEER level. According to JARN, several manufacturers have increased their inverter models to address increasing demand for ATWs and VRFs in China (JCI-Hitachi, Danfoss, Panasonic, Mitsubishi). Inverter scrolls should also be a major growth driver in the US driven by regulation favoring variable speed control and as costs fall. Japan remains the leader in global inverter technology. Penetration of inverters has accelerated with stricter energy-saving standards.

With the overall HVAC market continuing to be stable in most aspects, evolving strategic decisions around compressor initiatives/technology will stand out as key competitive differentiators among OEMs and incumbent compressor suppliers, but we think EMR remains well positioned as the dominant player that is evolving successfully as technology steadily improves.

Table 108: Compressor Dynamics by Market Tier

Tier	% Market	Comments
Entry Level (14 SEER)	~70%	Traditional scroll remains the prevailing technology solution here, where EMR Copeland has a dominant share.
Mid Level (15-18 SEER)	~25%	There has been a lot of talk over the past few years of OEMs (particularly Daikin, where EMR has had a dominant share) vertically integrating compressor supply and bringing inverter technologies down market to more mid level products. However, this has been slow to develop, as evidenced by the recent agreement between EMR and Goodman to use Copeland modulating compressors for the next gen 16-18 SEER products. EMR has invested heavily here, and remains well positioned, though this remains a longer term dynamic to keep an eye on.
Premium (18+ SEER)	~5%	Inverter technologies are primarily focused on this market segment, which represents <5% of the overall market currently, but at high margins for OEMs.

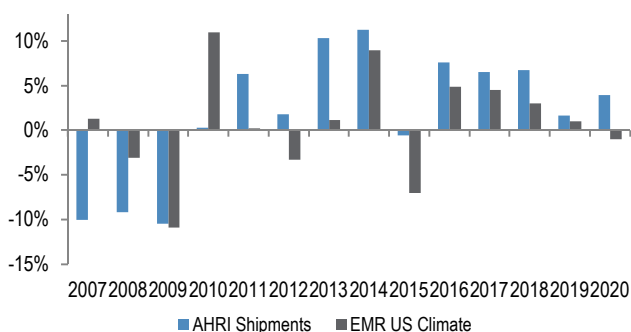
Source: J.P. Morgan

Compressor revenue growth continues to lag equipment somewhat

A portion of compressor demand is countercyclical repair activity, giving it less downside in a recession but less upside during growth periods. From an industry perspective, compressors for HVAC tend to follow an OEM's unit shipments, but they also have a countercyclical repair element to the growth as homeowners who fix (rather than replace) their system may buy replacement parts instead. These sales, sometimes called "service compressors," can make up anywhere from 10% to 20% of the industry by our estimates. This is one reason why EMR US Climate revenues outperformed in 2007-10 but have since lagged in the recovery as repair activity has normalized. From a mix perspective, the decline in repair activity is also generally negative as repair compressors are sold through distribution at a higher margin/ASP than the units sold to the OEMs.

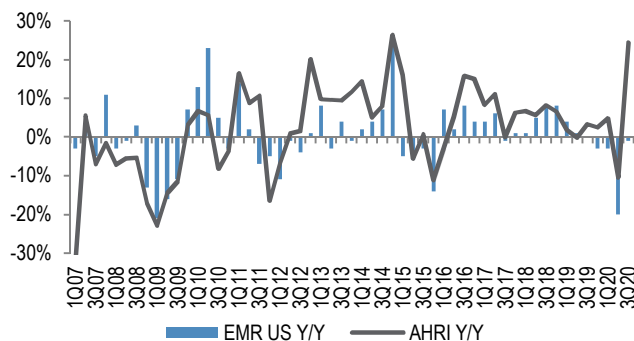
Figure 255: EMR US Climate vs. Industry AHRI Shipments

Y/Y % Change



Source: Company reports, AHRI

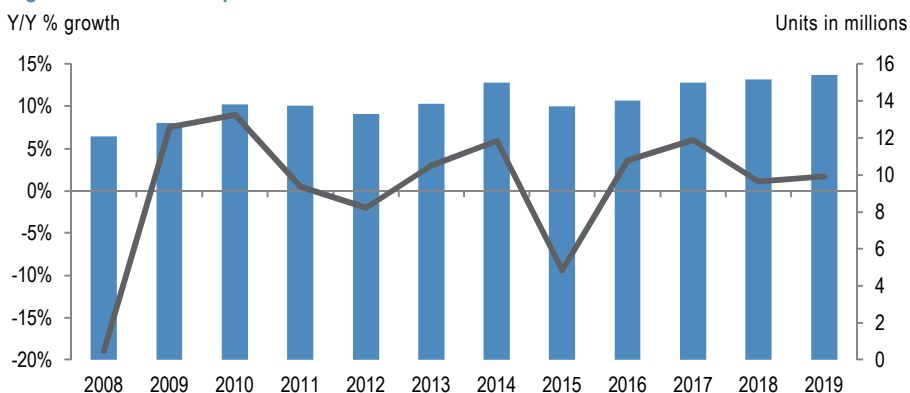
Figure 256: EMR US Climate vs. Industry AHRI Shipments (Quarterly)



Source: Company reports, AHRI

According to JARN, there was little growth in global demand for scroll compressors after the ~6% growth in 2017, with 2018 and 2019 seeing LSD growth. Due to uncertainties around trade and tariffs, China's market (the second biggest market behind the U.S.) declined ~7% in 2019, somewhat offsetting U.S. growth of ~5%. Major European markets declined >1% given uncertainties around Brexit and slowing manufacturing in the region. Previously, JARN noted scroll compressor demand was partially driven by increasing refrigeration applications in Asia and the food industry globally, and said that inverter demand has not gained a significant foothold in the US, with less than 3% of unitary products shipped in the US inverter-driven in 2016. It still expects scroll compressors to develop towards inverter, new refrigerants and large cooling tonnage.

Figure 257: Scroll Compressor Market

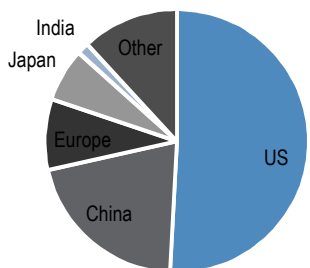


Source: JARN

Competitive structure: Copeland remains the leader

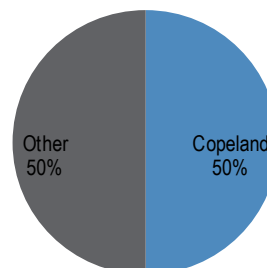
Emerson's Copeland business remains the dominant player in Scroll compressors, the primary product used in North American unitary AC. As a technology leader in this space, Copeland had an extremely strong cycle over 2003-08, taking advantage of the proliferation of scroll (which moved from 50% penetration of the market to over 85%) and leveraging strong relationships with share-gaining OEMs like Goodman. Copeland customers include Carrier and Rheem, though Carrier uses LG at lower efficiency levels. According to JARN, Copeland still takes about half of the scroll compressor market for air conditioning applications.

Figure 258: Scroll Compressor Market Unit Split



Source: J.P. Morgan estimates and JARN

Figure 259: Scroll Compressor Market Share (Worldwide)



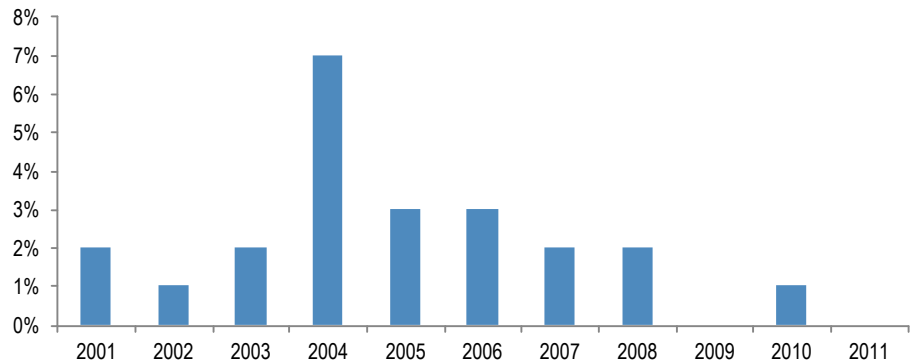
Source: J.P. Morgan estimates and JARN

Indeed, in its 10K's, management has previously pointed to an average 2% annual revenue growth (7% in 2004 alone) from penetration gains over the course of the last

cycle. The technology here was so strong that Bristol Compressors, the other main supplier, was sold in 2007 as part of the JCI/YRK deal for \$350 mm, or ~0.5x sales.

Figure 260: Climate Penetration Gains Were a Key Driver of EMR Climate Growth Last Cycle

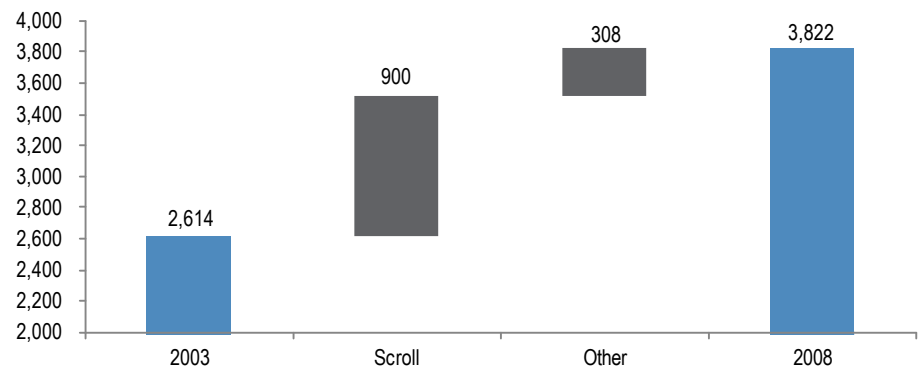
% sales growth from penetration gains (per 10-Ks)



Source: Company reports, J.P. Morgan estimates.

Figure 261: Scroll Accounted for 75% of Climate Sales Growth Last Cycle

\$ in mm

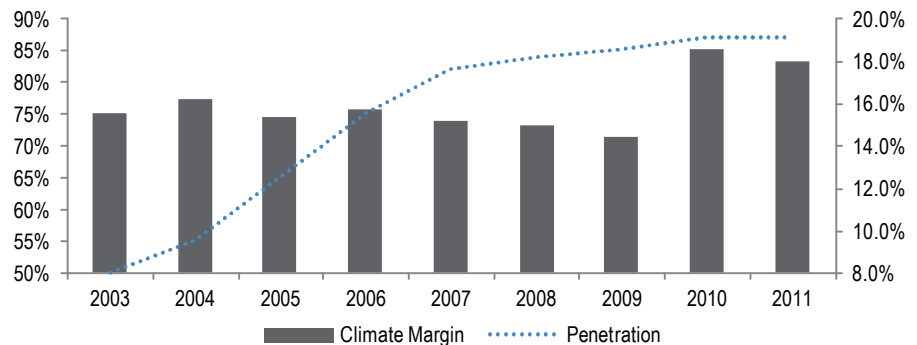


Source: Company reports, J.P. Morgan estimates.

Figure 262: Climate Margins Also Benefited from Scroll Compressor Penetration

Scroll Penetration

Climate Margin



Source: Company reports.

According to JARN, Emerson dominated the scroll compressor market for AC applications with about half the market, is a leading scroll compressor manufacturer in the US with Danfoss and Bitzer. In China, with rapid changes in policies and

demand, EMR continued to lead the market, though JCI, Hitachi and Panasonic were right behind them, while Danfoss and Daikin are catching up. Moreover, EMR entered the VRF inverter scroll compressor segment late, while JCI-Hitachi's models dominate. Copeland and Danfoss dominate the CO2 subcritical scroll compressor segment of the refrigeration market. Therefore, beginning this cycle, and going forward, we think Copeland remains a strong player but will not recreate the share gains from last decade. Much of this reflects a "catch up" of its major competitors that have been able to develop their own technology (getting around the initial Copeland patent) as scroll compressors become a more mature product. This includes competitors like Danfoss, which entered in 2006 through acquiring the Carrier Scroll Technologies JV, but also Asian players like LG and Mitsubishi, which manufacture scroll product for both their own systems as well as US OEMs, and Asian manufacturers are accelerating their expansion into the US. As a result, we believe the major unitary OEMs have made an effort to diversify their compressor supply to Asian players. Indeed, Lennox has previously talked about supply chain initiatives (including Asian compressor suppliers) as a key element of its annual sourcing savings. Bottom line, Emerson remains the dominant player here but not necessarily a share gainer as it was last cycle.

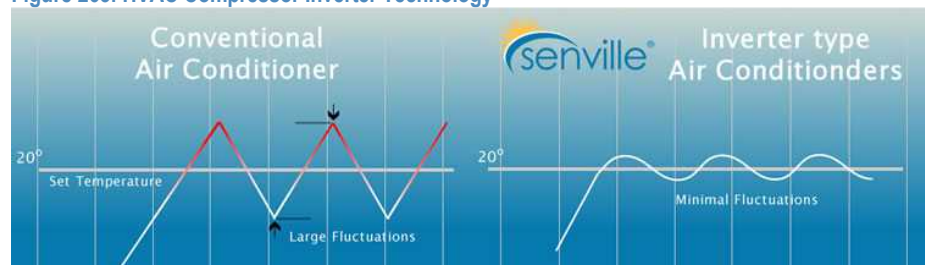
Inverter technology the next wave of innovation, led by Asian VRF players . . .

The next major advance in compressor technology is coming from Asian players in the form of inverter technology, which converts current to allow more smooth variation in rotary compressor operations. Traditional compressors, including scroll, had typically regulated temperature by either running the motor at full speed or turning it off completely. An inverter is essentially a variable frequency drive, smoothing the pace at which the motor runs to maintain the temperature set point without turning the machine on and off. This makes the compressor both more efficient and less prone to breakdown. Daikin estimates inverter AC systems to save up to 30% in energy consumption, compared to non-inverter systems. The technology can be used in any HVAC unit but is more common among higher-efficiency systems like VRF systems.

Inverter technology is common in Asian markets like Japan and China, where players like Daikin and LG have a significant share of the compressor market, and the region's large unit volume has helped these suppliers reach critical mass with scale and cost advantages versus other suppliers. Japan remains the leader in global inverter technology, while in China, several manufacturers have increased their inverter models to address increasing demand for ATWs and VRFs (JCI-Hitachi, Danfoss, Panasonic, Mitsubishi) and to improve efficiency and comply with China's energy efficiency requirements. JARN previously estimated that inverter penetration in China stood at ~65%, and the implementation of the new energy standard for chillers has increased the use of inverters in light commercial AC, with all Chinese manufacturers accelerating the development of inverter scroll compressors. Inverter penetration is being driven by refrigeration equipment growth, and has accelerated recently with stricter energy-saving standards.

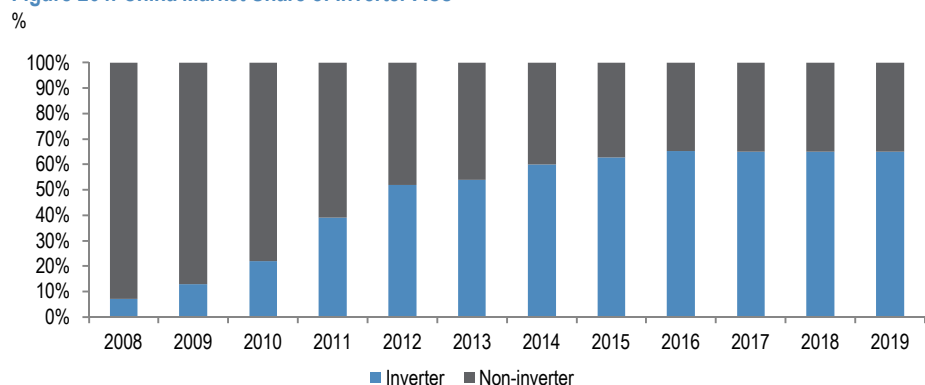
JCI-Hitachi has seen rapid growth in DC inverter scroll compressors, with a focus on VRFs and mini-VRF applications, and dominates the market here. Danfoss is also accelerating the development of inverter products, and Panasonic and Mitsubishi have added inverter models. Emerson presented fewer new products at this year's AHR Expo as most of the spending will come around compressor redesigns around 2023 refrigerant and efficiency changes, and entered the inverter segment late.

Figure 263: HVAC Compressor Inverter Technology



Source: Senville

Figure 264: China Market Share of Inverter ACs



Source: JARN, AVC, CMM

... and still somewhat limited in unitary product, but beginning to show up in higher-end systems

The use of inverter technology is so far more limited in North American unitary markets. Previously, JARN had estimated penetration at less than 5% of North American unitary systems, and EMR had estimated ~2%, while Daikin at this year's AHR Expo called penetration of inverter compressors at 2-3% of overall volumes and JARN still sees low penetration today. They are mainly utilized for unitary and rooftop systems, and primarily found in the ultra-premium 18-25 SEER products. The main issue in adoption is not technology but rather cost as inverter compressors are roughly 25-30% more expensive, which, at the moment, makes it hard to design into mass-market systems at a reasonable price. This cost may come down over time, however, and there has been buzz over the past few years of penetrating more mainstream segments like the 15-17 SEER level. We've seen no indication of this occurring yet, and indeed, leading inverter players like Daikin have gone with Copeland as supplier for new 15-18 SEER products, discussed further below and an indication that mainstreaming inverter technologies are still a ways off. Longer term, inverter scrolls are still expected to be a major growth driver in the US driven by regulation favoring variable speed control, by greater emphasis on energy savings, and as costs continue to fall.

Almost every OEM we have met with at various trade shows has been showcasing their use of inverter compressors in high end products (>19 SEER), though Trane has commercialized a 17-21 SEER line with LG that costs as much as one with a 2-stage variable speed compressor. Lennox recently launched a 20 SEER product with an LG variable speed compressor. They worked closely with LG to get the cost structure down to do this, and are not sure how much lower down inverters will go in SEER level, since you can have multi-stage compression in 15 to 16 SEER units that get you most of the way to the efficiency levels and comfort of a variable speed with less cost. Lennox is not as focused on bringing variable speed technology into low-end products as some competitors, rather they try to think about how to meet customer needs at the lowest cost. Scroll still represents the vast majority of resi and light commercial products and Copeland and LG are their biggest partners. Essentially, Lennox views inverter compressors as an evolutionary shift, not revolutionary, noting that Moore's law does not apply to thermodynamics.

Daikin/Goodman vertical integration more hype than reality at this stage

Daikin remains a leading maker of inverter compressors, and after acquiring Goodman, it highlighted the ability to vertically integrate its compressor supply as a key revenue synergy. In our conversations with Daikin, we believe the company has plenty of capacity to ramp inverter production for the US markets with minimal additional capital cost, making it the most likely candidate to proliferate inverters for unitary in a cost-effective way. The first action on this front came in early 2014, when the company launched its initial unitary product with inverter technology, including a Daikin-branded 17-20 SEER heat pump. The question is where this expansion goes next, and we have spoken with reps who have indicated they plan to push inverter compressors down as far as 16 SEER. However, our sense from meetings with the company had been that there may be some lingering challenges with the engineering and product design, something that may delay execution on these initiatives, and the partnership with Copeland essentially confirms this. Other OEMs have also talked about vertically integrating the compressor supply chain, however we noted less urgency around this at trade shows, a potential signal that progress here is coming slower than expected for those who are working on it. Goodman is now being run mostly by Daikin officials. At this year's AHR Expo, the company commented on penetration of inverter compressors, seeing it grow but still at 2-3% of overall volumes, well short of initial targets set when the merger happened, though it believes others like LG and Panasonic are looking to sell into the US. In the U.S., Goodman offers rooftop units with inverter scroll compressors. Most recently, Daikin introduced a new residential, whole house system called DAIKIN FIT System (up to 18 SEER, inverter compressor). This smart HVAC system connects to ducted solutions, and Daikin believes it offers an affordable alternative as a mid-efficiency inverter, to other high-tiered, expensive inverters available in a saturated market, and offers up to 30% savings in electrical consumption vs non-inverter ACs. As a side discharge system, it is also more compact in size than traditional "cube style" systems with top discharge, and can be ground or wall-mounted. This benefit of freeing up space is particularly relevant in places like the West Coast, Toronto, Montreal and New England. Trane also offers a similar side discharge A/C called XR16, for difficult-to-access and tight-space applications as well.

Emerson is also investing in expanding their compression portfolio, and appears relatively well positioned for now

The dynamics around vertical integration of compressor supplies and proliferation of inverter technology at Daikin are most relevant for Copeland, which we estimate had as much as ~90% of Goodman compressor supply historically and would be most at risk of de-contenting. Keep in mind that, while this was not quantified by Daikin, the volume related to internally sourcing compressors for Goodman product was a key sales synergy in the acquisition. We believe this is one of the drivers for EMR management's emphasis away from residential compressors and toward controls and commercial/refrigeration applications.

We think it's most instructive to look at the dynamics across three main market segments: entry-level (14-15 SEER), mid-tier (15-18 SEER), and premium (18+ SEER). On the low end, Copeland's traditional scroll product remains a cost effective solution for entry level products and we see little risk of de-contenting here. On the premium end, Copeland launched some variable speed compressor products, but adoption here is likely spotty with most traditional inverter players already having a technology lead here and strong positions. The key question is how far Daikin (and others) are ultimately willing and able to go down market to integrate the compressor supply. On this front, Copeland's next generation two-stage scroll compressor is offered in Goodman's new 16-18 SEER systems, the first OEM partnership for the new compressor. This clearly demonstrates, in our view, that Copeland is not going away in the middle tier of the market, and initiatives by Daikin to insource the compressor supply and bring variable speed technologies down market remain slow to take off, with EMR remaining well positioned.

Table 109: Compressor Dynamics by Market Tier

Tier	% Market	Comments
Entry Level (14 SEER)	~70%	Traditional scroll remains the prevailing technology solution here, where EMR Copeland has a dominant share.
Mid Level (15-18 SEER)	~25%	There has been a lot of talk over the past few years of OEMs (particularly Daikin, where EMR has had a dominant share) vertically integrating compressor supply and bringing inverter technologies down market to more mid level products. However, this has been slow to develop, as evidenced by the recent agreement between EMR and Goodman to use Copeland modulating compressors for the next gen 16-18 SEER products. EMR has invested heavily here, and remains well positioned for now, but this remains a longer-term risk.
Premium (18+ SEER)	~5%	Inverter technologies are primarily focused on this market segment, which represents <5% of the overall market currently, but at high margins for OEMs.

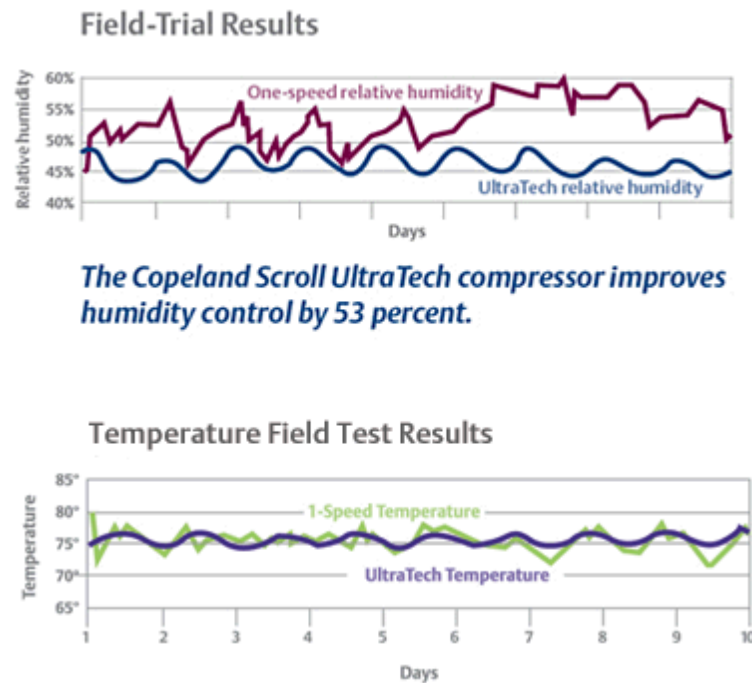
Source: J.P. Morgan

Further to this, Emerson has noted during its investor days that variable speed compressors represent only 2% of the US resi market (JARN estimates ~4%), and aimed solely at 18+ SEER products, though modulating compressors (15-18 SEER) combined with pure variable speed could get to 15% of the overall market at some point. Modulating technology sits between single-stage fixed capacity and pure variable speed, and adjust capacity either in steps or a continuous fashion for applications with varying loads or changing ambient conditions. This reduces compressor cycling to achieve a higher part-load efficiency and provides better humidity control at lighter loads, where fixed capacity systems can struggle. EMR is selling 5x more modulating than variable speed compressors. They made it clear they are not competing against variable speed as their product is significantly less expensive, and they believe they can outperform the market by holding share and mixing up. They've developed a 60 hp modular scroll compressor in Europe. Overall, we view the proliferation of inverter technology and talk around vertically integrating the compressor supply to be more hype than reality at this stage, and not much of a near-term headwind for Copeland, but still something to monitor longer term.

At its Investor Day, Emerson talked about investments in electronics, and cited a pick up on penetration in NA as one of their competitors went out of business. In the context of the new efficiency standard coming in 2023, the company expects to refresh its portfolio of compressors, and to expand and update their broad modulation technologies. Indeed, at this year's AHR Expo, they presented fewer new products as most of the spending will come around compressor redesigns around 2023 refrigerant and efficiency changes. They cited a unitary market of 9mm systems a year, and see themselves with strong position across OEMs and applications, from base 13 SEER to mid-tier, and 15 to 17 SEER to high-end systems. With the phase out of the 13 SEER in 2023, that piece of the market will go away, where they see mainly Asian players and rotary technology, and EMR thinks it's well positioned as the market moves towards its higher SEER systems. In China, the company developed a strategy focusing on large-capacity, shifting from production lines from 3 and 5 hp products, to 8 hp products. On inverter scroll compressors, the company entered this segment for VRF late and is now aggressively developing them to catch up. They developed 7hp inverter compressors to meet the needs of the mini VRF market in China. Still, its latest Copeland Scroll two-stage compressors are competing well with inverter rotary compressors, as affordable solutions for OEMs in 15/16 applications, according to JARN.

Previously, Emerson had also talked about protecting its dominant share of scroll through new product introductions and stepped up investments in people and facilities. The company announced a JV with Shanghai Ruking Electronics Science & Technology in 2014 to focus on the development of variable speed inverter technologies, and we think this partnership is something to keep an eye on moving forward. On products, the next generation scroll UltraTech compressor has modulating technologies that shift between 67% and 100% capacity, improving efficiency by up to 5.5%. They also invested in fixed-speed compressors and previously laid out a strategy to regionally optimize products in emerging markets and offer solutions for every product type and market, building out new machine and service centers, as well as manufacturing capabilities in places like China, Germany and Dubai. The Dubai solution center was started early-mid 2018, and is now running at 80%+ utilization.

Figure 265: Copeland UltraTech Delivers Humidity and Efficiency Improvements



Source: Company reports

The company also opened an innovation center for building controls and HVAC research in 2016, called The Helix. The center has five real-life environments (data center thermal management, residential connected home, commercial building, supermarket refrigeration, and food service operations), with 40,000 square feet of product development space on the University of Dayton campus, as well as a 2,000 square foot house inside of an environmental chamber where they can change conditions (humidity, temperature) to run experiments. They also have an initiative to model and conceptualize architectures for supermarkets, and they currently have some installations with customers already. The goal is to bring in a diverse range of people from different backgrounds both inside and outside of the company and industry to come up with ideas to improve products and shape the industry's future. The building has a 50-ton rooftop unit with a separate 20-ton rooftop unit and a VRF system, with Emerson building controls. They have visible ductwork and a station for building metrics to be electronically monitored. The unique setup will allow the company to simultaneously test various settings in the different environments to optimize conditions and apply learnings across platforms.

Turning to Cold Chain, according to JARN, the high and medium temperature cooling storage market has seen remarkable growth in the past few years. Sales of refrigeration scroll compressors were up in 2018, with all compressor manufacturers including this segment as a key project going forward. Refrigerated warehouses, trucks, buses and display cases have all shown strong growth potential. Scroll compressors for refrigeration have market potential in particular in China, India, and Southeast Asia given the high proportion of young people, with a high percentage in Europe, but there are still few refrigeration applications, representing a small number of scroll compressors overall. In China, scroll compressors are 5% of compressors used in refrigeration, but there is a rising trend there as the food loss rate is high and full cold chain has yet to be achieved. JARN has again highlighted Copeland and Danfoss as the two companies that appear to be concentrating most on China's refrigeration market and benefitting from these trends. Among cooling tonnage from 3 to 16 hp, scrolls have gained market share from semi-hermetic reciprocating compressors. Scroll compressors from 5 to 8 hp have the largest market share in the China refrigeration market. On the light commercial side, demand for refrigeration applications has rapidly expanded in the last few years. JARN has highlighted EMR as the global leader in refrigeration, while other players include Danfoss, JCI-Hitachi, Panasonic and Invotech.

Copeland is also expanding further into new markets, particularly refrigeration cold chain and transportation in emerging markets like China and ME. In cold chain, Emerson recently expanded in food and cargo monitoring with end-to-end monitoring presence across the cold chain industry (they highlighted their ProAct solution). Through small sensors that track temperature and location, paid for on price per load, this gives them a good position on monitoring perishable goods, an area driven by food safety regulations. They are focused on food quality at the grower/shipper/producer/retail level and have invested in managed service operations to analyze the data being fed into the cloud. Cooper Atkins, Locus Traxx and PakSense fit into this strategy. In Asia, Emerson has highlighted the opportunity in the China market frequently, with opportunities for growth from clean air initiatives helped by a China government push, with >20% growth in 2017-2018 from demand related to air purification and clean air initiatives, while 2019 is expected to see declines as investments are deferred on economic conditions.

VRF/Ductless

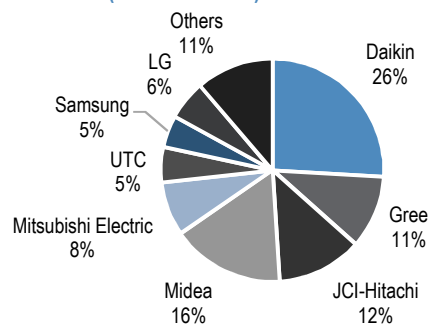
A note on terminology: There are a range of terms associated with ductless split systems, not all of which are used consistently by industry participants or trade press. A “mini-split” (less commonly called a “multi-split”) most often refers to a smaller residential application. Most define “VRF” (variable refrigerant flow) as being specific to commercial applications, though others will use the term broadly to refer to any commercial or resi system with multi-zone cooling. Daikin calls its ductless split systems “VRV” (variable refrigerant volume), a term it developed and protected, but this is functionally the same as VRF.

In this report, we generally use “mini-split” to refer to residential ductless applications and “VRF” for ductless commercial systems.

Both the residential mini-split and commercial VRF are to be differentiated from window and room air conditioning systems (a more commoditized product sold through retail channels).

Ductless products have been touted for several years as potentially disruptive technologies that could structurally change the North American HVAC industry, but sentiment has gradually shifted toward a consensus that these are evolutionary and not revolutionary, with tangible benefits for specific applications but less of a threat to traditional ducted systems. To be clear, ductless products have been growing strongly off a low base, though this growth rate has cooled somewhat over the past couple of years and underperformed initially lofty expectations. Ultimately, we think US OEMs have handled the situation well, partnering with Asian players on technology and bundling ductless products with existing solutions in specialty applications. In other words, it is becoming increasingly clear in our view that VRF will not be a “chiller killer.” On the residential side, we expect to continue to see solid growth off a low base, but this remains more of a niche product, while commercial penetration should continue for smaller commercial buildings. Overall, for decades the North America market has been remarkably stable—the same products (ducted unitary with some applied systems), dominated by the same major players (Carrier, Goodman, Trane, Lennox, etc.). We expect some gradual shifts around the margin as ductless increases penetration and moves to ~15% of the industry over time, with Asian players remaining the technology leaders and capturing a slice of the market either directly (as Daikin/Mitsubishi have) or through JV/partnerships. This puts some pressure on the US OEMs to remain relevant, and ductless revenues probably come at a below-average margin, but the ultimate impact should remain somewhat limited as the penetration likely occurs gradually. Midea has provided the below breakout of the global VRF market, with Daikin taking the lead.

Figure 266: Global VRF Market (2017 unit sales)



Source: Midea

What Is a Ductless Mini-Split/VRF System?

As background, a ductless split system, typically referred to as a “mini-split” or “VRF” system, is characterized by an outdoor condensing unit connected directly to one or more indoor air handling units. The term “mini” relates typically to the small indoor units, which typically mount on the wall or ceiling and are controlled individually in each room. The key difference versus a traditional “central air” system is the lack of ductwork—keep in mind that the US is one of the only countries in the world where ducted AC is the convention, as mini-splits are common in Europe and especially Asia. The term VRF (variable refrigerant flow) is sometimes used broadly to characterize ductless split systems; in other cases, it is used to specify either (1) ductless commercial systems, or (2) more advanced ductless split systems that have variable speed compressors and/or a more efficient line sets with separation tubes to minimize refrigerant loss.

Figure 267: Residential Mini-Split Indoor Evaporating Unit



Source: Company reports, used with permission

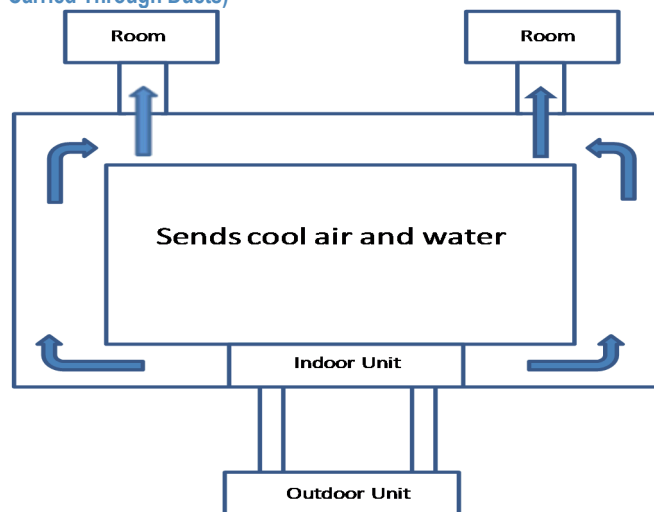
Figure 268: Residential Mini-Split Outdoor Condensing Unit



Source: ACHR, used with permission

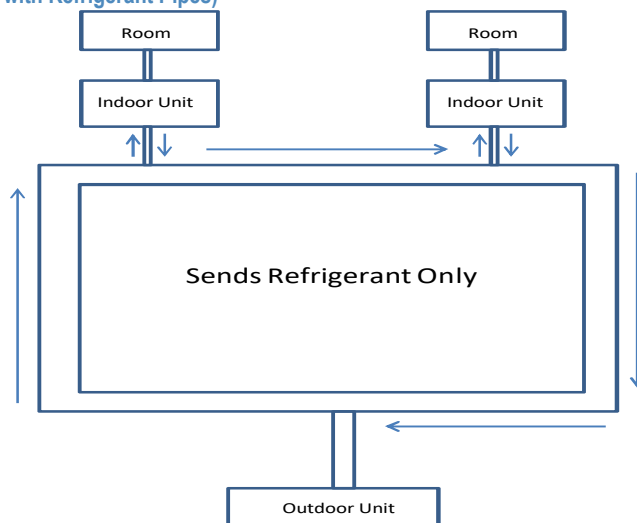
A simple way to think of the difference between the two products is that a ducted system will send refrigerant to just one indoor unit and pushes cool air/water through the building, whereas a ductless product sends refrigerant only to multiple indoor units.

Figure 269: Ducted (Outdoor and Indoor Integrated and the Air Is Carried Through Ducts)



Source: Daikin, J.P. Morgan

Figure 270: Ductless (Outdoor and Indoor Separated and Connected with Refrigerant Pipes)



Source: Daikin, J.P. Morgan

Mini-splits in residential applications

Within the US, mini-splits have traditionally been used in applications where there is insufficient space for duct work, such as older homes, multi-family applications, or add-on renovations. Like a ducted unitary product, mini-splits require a licensed contractor to install.

There are several advantages to mini-splits, including:

- *More efficient cooling of targeted zones*—The key attraction is zoned cooling, allowing the home owner to save money by targeting only selected areas of the house. For example, “empty nesters” can choose to avoid cooling bedrooms that are unoccupied most of the year.
- *Energy losses in ductwork*—The DOE estimates that duct losses can account for as much as 30-40% of HVAC energy use. Ducts are typically run through attic crawlspace that, in hot regions such as the southern US, can reach temperatures upward of 150 degrees.
- *Suitability for add-on or unconventional applications*—This includes (1) additions to existing homes where adding ductwork may not be practical, (2) old homes with no ductwork, or (3) small lots where there are either footprint challenges or noise constraints.
- *Contractor appeal*—A mini-split cooling system can be more easily installed by a contractor, the result of less complex ductwork. Anecdotally, many describe installations of less than a half a day for a ductless system versus multiple days for a ducted unitary installation. Many contractors also talk about making higher profit margins on a mini-split installation due to the reduced amount of labor.

On the other hand, there are still a number of headwinds to adoption. These include:

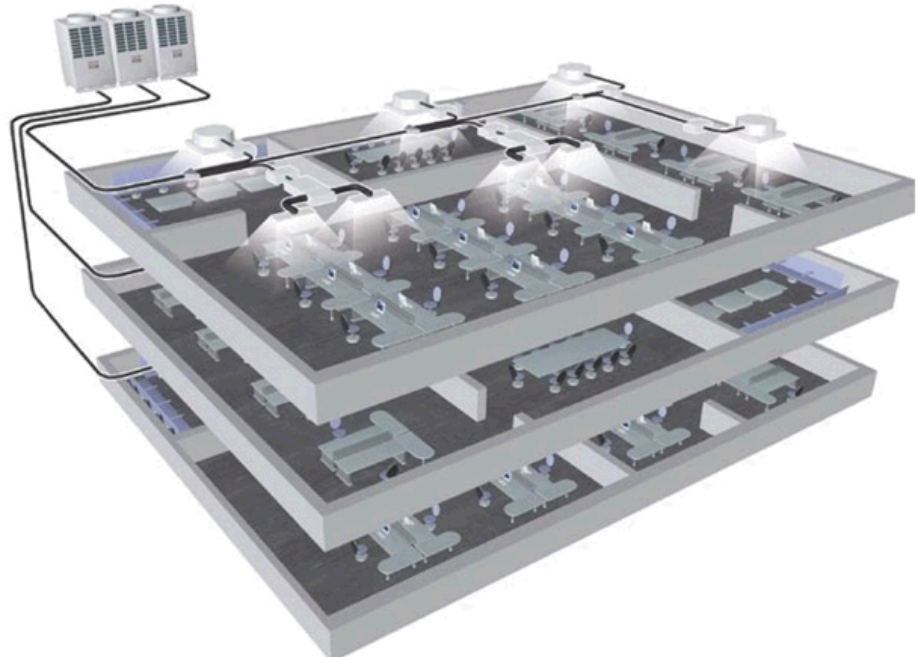
- *Higher installation costs*—This is the biggest headwind from a purely financial perspective. Initial costs for mini-splits run at about \$1,500-2,000 per ton of cooling capacity, ~30% more than central systems (not including ductwork) and about twice as much as window units of similar capacity. This means that customers are paying upfront for energy savings realized over time.
- *Unitary installed base*—With ducted unitary product making up the vast majority of the US installed base, most consumers will default to simply replacing the condenser to fit with an existing system. The hurdle to a contractor selling a ductless solution is higher.
- *Aesthetic acceptance*—Most homeowners are accustomed to ducted air and don’t like the appearance of a visible wall unit. Interestingly, market research has frequently noted aesthetics as the primary consumer issue with mini-splits. In fact, many homeowners believe the resale value of their home may suffer if they install a mini-split versus a traditional ducted system.
- *Limited penetration in new construction*—Similarly, the use of mini-splits in new home construction is minimal today as ducted systems remain the norm and are perceived by homebuilders as more attractive/saleable. This limits a key avenue for new penetration, limiting mini-splits’ market share gains to the replacement/add-on market.

- *Contractor buy-in*—Mini-split awareness needs to come through dealer-contractors, many of which are not familiar or comfortable pitching the product. Installation costs can also be higher if there is a lack of qualified contractors. To be sure, this is changing, and we continue to hear more enthusiastic comments from the channel, but they will need continued buy-in before wider penetration can occur.

Ductless VRF applications for commercial

Ductless applications in commercial are larger, but broadly similar to residential in that they feature outdoor condenser unit(s) with multiple indoor units providing zoned cooling. Commercial VRF applications are also more likely to utilize more advanced types of technology such as variable speed compressors. The VRF systems can be installed in either new construction or replacement/retrofit.

Figure 271: Illustration of Commercial VRF Application for a Multi-Story Building



Source: Toshiba, used with permission

The advantages/disadvantages to a VRF system (versus a traditional unitary or applied solution) are similar to that seen in residential. However, because commercial applications will be more varied/unique, a VRF system's suitability will depend on the specifics of the building and the customer.

- *Advantages*—In general, the VRF system will be more efficient than a comparable unitary or applied system, driven by the same concepts as residential systems (less energy loss in ducts, zoned cooling, etc.). Zoned cooling is particularly attractive, for example, to multi-use buildings where individual tenants are responsible for their own electricity bills. There have been a range of studies that compare VRF systems with comparable rooftop units, with estimates of the savings ranging from 10% to 40% annually (see below).

- *Disadvantages*—As with residential, the primary hurdle is the higher first cost for a VRF system. A GSA report estimated this difference at ~15% for a 120 ton office application, but it will vary depending on the building. For much of the smaller commercial unitary applications, customers will be very sensitive to first cost and have little incentive to opt for a more expensive installation. From an application perspective, zoned cooling systems will be less appropriate for buildings with large open spaces, such as warehouses or big box retail. Lastly, many commercial contractors don't have sufficient familiarity with the product, and it will require training from the OEMs and distributors over time.

The charts below represent our best estimates on the cost differential and energy savings associated with VRF versus traditional systems. Interestingly, we see that on an all-in installation basis, VRF is actually comparably priced due mainly to additional piping and controls costs on traditional systems. While this may make VRF more attractive on a relative basis for new installations, we note that the higher equipment cost of VRF makes it less attractive in the much larger replacement market.

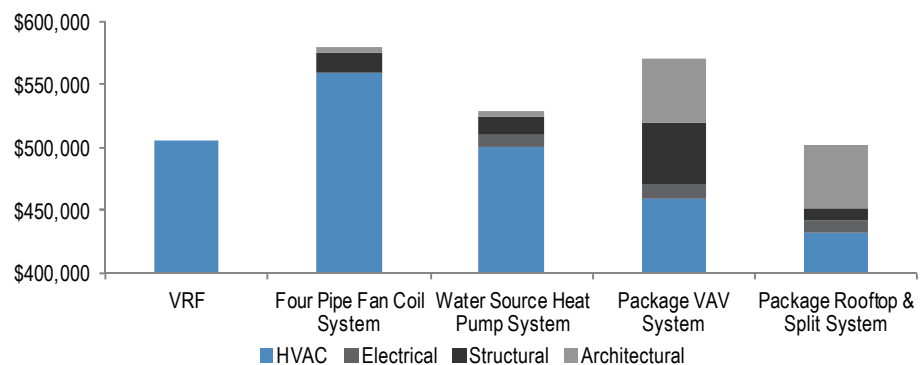
Table 110: VRF versus Traditional HVAC Systems All-in Cost Estimates (2016)

	VRF	Four Pipe Fan Coil System	vs. VRF	Water Source Heat Pump System	vs. VRF	Package VAV System	vs. VRF	Package Rooftop & Split System	vs. VRF
Equipment Costs	\$180,000	\$120,000	-33%	\$125,000	-31%	\$150,000	-17%	\$100,000	-44%
Ductwork, GRDs, Insulation	\$120,000	\$125,000	4%	\$125,000	4%	\$130,000	8%	\$135,000	13%
Piping	\$50,000	\$115,000	130%	\$75,000	50%	\$5,000	-90%	\$35,000	-30%
Controls	\$25,000	\$50,000	100%	\$40,000	60%	\$55,000	120%	\$40,000	60%
Commissioning & Air Balance	\$15,000	\$20,000	33%	\$20,000	33%	\$15,000	0%	\$20,000	33%
Warranty	\$5,000	\$5,000	0%	\$5,000	0%	\$5,000	0%	\$2,000	-60%
Project Management	\$25,000	\$30,000	20%	\$25,000	0%	\$25,000	0%	\$25,000	0%
Overhead & Profit	\$85,000	\$95,000	12%	\$85,000	0%	\$75,000	-12%	\$75,000	-12%
Total Contract Amount	\$505,000	\$560,000	11%	\$500,000	-1%	\$460,000	-9%	\$432,000	-14%

Source: J.P. Morgan estimates

In addition, traditional systems also require additional installation architectural, structural and electrical costs related to installation, bringing the all-in costs higher.

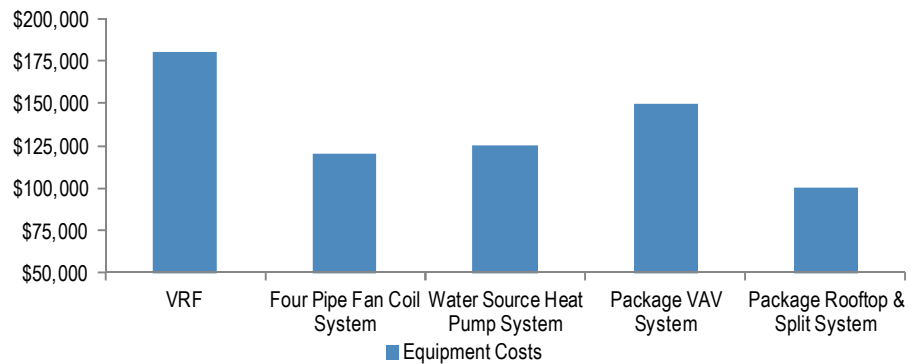
Figure 272: VRF versus Traditional HVAC Systems All-in Cost Estimates



Source: J.P. Morgan estimates

While we note that the all-in cost of VRF may be below that of traditional systems, we point out that the key decision factor for customers (particularly those who are replacing) is the equipment cost, where VRF is still more expensive. This remains the key hurdle to VRF adoption.

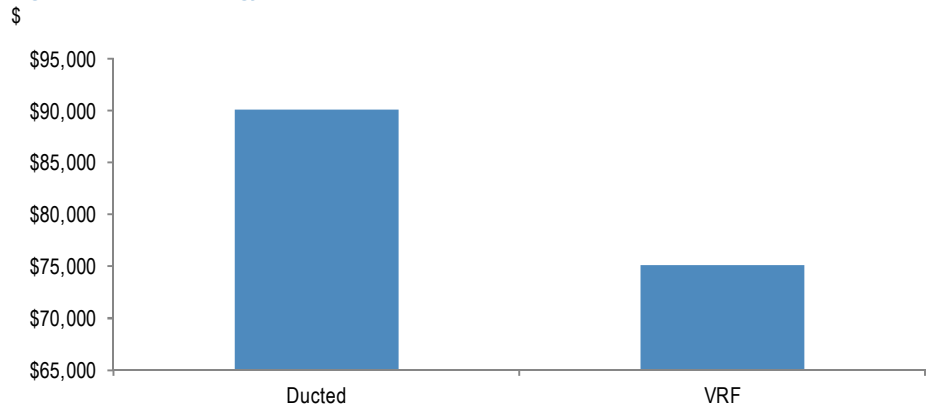
Figure 273: VRF versus Traditional HVAC Systems Equipment Cost Estimates



Source: J.P. Morgan estimates

Offsetting the higher first cost of VRF are the associated energy savings, which we peg at about 15-20%. This would translate into approximately \$10-20K in cost savings per year, meaning the higher equipment cost could be recouped over a period of three to five years.

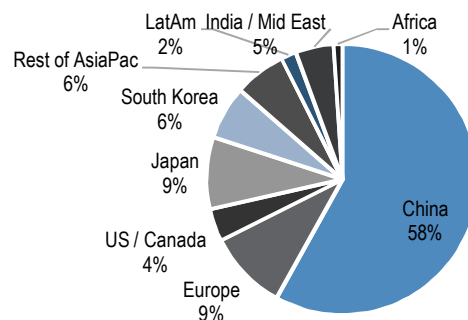
Figure 274: Annual Energy Cost Difference Between Traditional Ducted and VRF



Source: J.P. Morgan estimates

JARN estimated the global VRF market size at 1.86 million units in 2019, up 4.9% y/y, with China taking the largest market share by far, while the US VRF market scale remains small. China, Japan, and South Korea combined make up 70% of the market.

Figure 275: Global VRF Market Share By Geography



Source: JARN

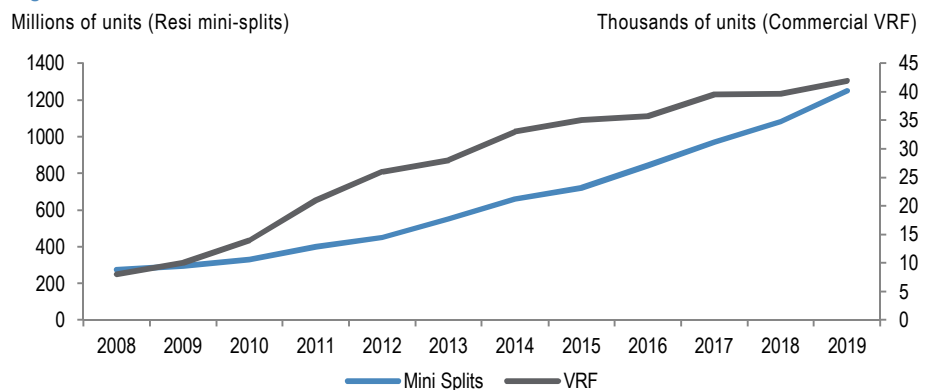
Where is commercial VRF most attractive?

Commercial VRF systems can be installed in a range of settings ranging from single-story small business applications to mid-sized buildings, though there are differences in opinion around which will see the greatest growth. Lennox sees the best opportunity in 3-10 story buildings (largely office-related), something that has traditionally been the domain of large rooftop units or smaller applied systems. Its logic is that these settings are large enough to absorb the first cost of the system but small enough that VRF economics still compare favorably relative to a large chiller. Lennox has talked to bundling its VRF applications with unitary products such as traditional rooftop units to offer broader solutions and encroach on smaller applied systems, serving institutional verticals like schools, lodging, light healthcare and small office. Trane expects penetration to occur across a broad spectrum of commercial applications, believing that the specifics of the building (such as layout, customer use, length of refrigeration line set, etc.) are more important than the size of the building specifically, and they see unique opportunities to solve problems by commingling VRF solutions with conventional systems. From a vertical perspective, Daikin has said it is targeting institutional applications in its North America VRV expansion, perhaps because these customers have longer payback thresholds.

Sizing the North America market

Because of its historically small size, it is difficult to find precise regular data of the North American ductless market. Research organization JARN estimated the US residential mini-split market at roughly 1,250,000 units in 2019, up 15% vs. 2018, and representing a ~15% CAGR since 2008. For commercial VRF, JARN estimates the 2019 US market at ~41,900 units (or ~LSD % of the global market). The US market was up ~5.8% y/y in 2019 and JARN estimates that the market has slowed in recent years vs. the 10%+ seen on average from 2011-2017. Looking at VRFs and mini-VRFs, the US market was up 9.6% in 2019, to a market size of 68,800 units according to JARN, led by growth in mini-VRFs as the higher efficiency vs. unitary systems and ability to provide cooling or heating for a specific room are increasingly appreciated given the increasing number of states that are tightening energy-savings and environmental regulations. VRF still represents only 5-10% of the commercial market overall. Because commercial systems carry a much higher value per unit, however, the two markets are closer to the same size on a dollar basis. Lennox has estimated the size of the US commercial VRF market at \$445mm in 2016, but their estimates are consistently a couple hundred million dollars lower than JARN's, where we have a more complete historical data set. In 2019, Trane also talked about a \$750-800mm market in NA in 2017.

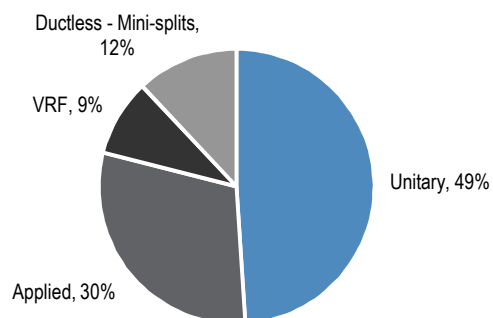
Figure 276: Size of US Ductless Market



Source: JARN; JP Morgan estimates

Figure 277: North America Large HVAC Market

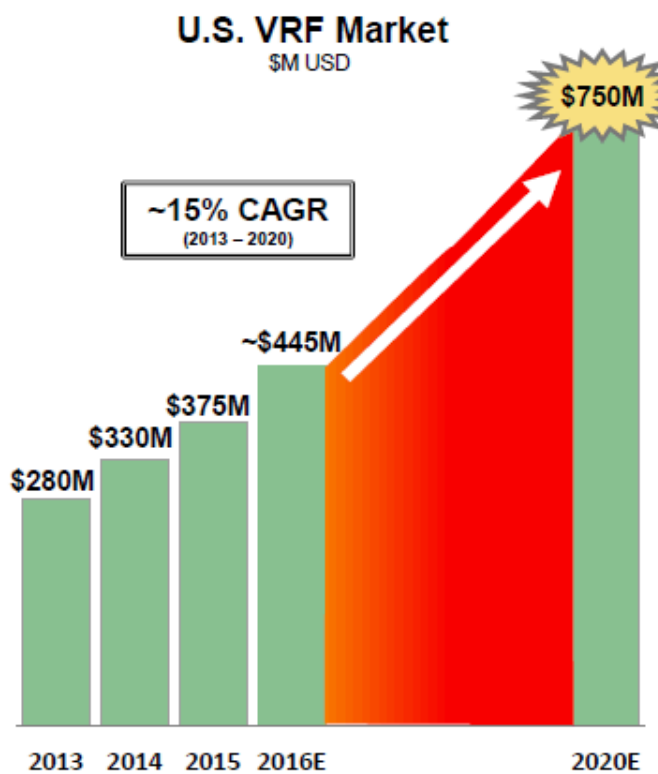
\$7B Market, 2019



Source: Ingersoll Rand estimates

Figure 278: US Commercial VRF Market Size

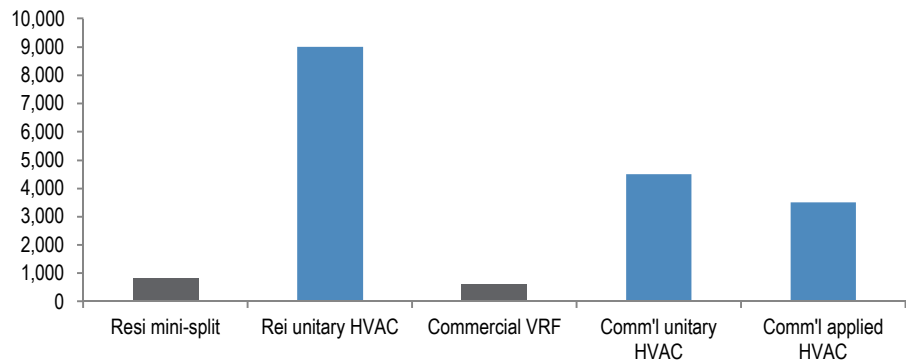
\$ in mm



Source: Lennox

Figure 279: Ductless Mini-Split/VRF Relative to Traditional Unitary/Applied HVAC Markets

Estimated North American industry size, \$mm

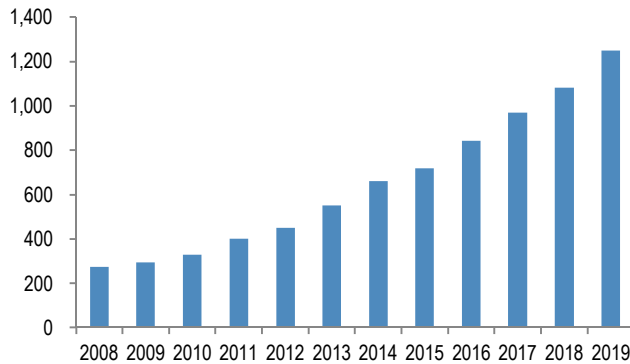


Source: J.P. Morgan estimates

Residential—At ~1,250,000 units, ductless split systems represent 10-15% of the overall residential market, growing at a mid-teens CAGR since 2005 (as background, mini-splits *are* included in the monthly AHRI shipments). Regionally, mini-split systems tend to be seen less in the core Southern markets, with outsized share in regions like the Northeast, Mid-Atlantic, and Pacific Coast. According to JARN, the US mini split market grew 15.3% in 2019.

Figure 280: Ductless Residential Shipments Have Grown Rapidly...

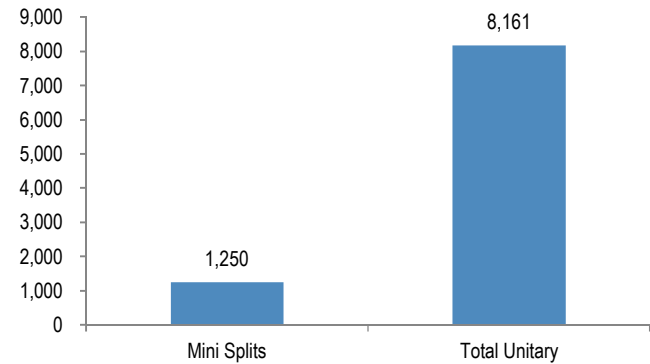
Thousands of units



Source: JARN, AHRI, J.P. Morgan estimates

Figure 281: ... but Are Still Small Relative to the Unitary Market

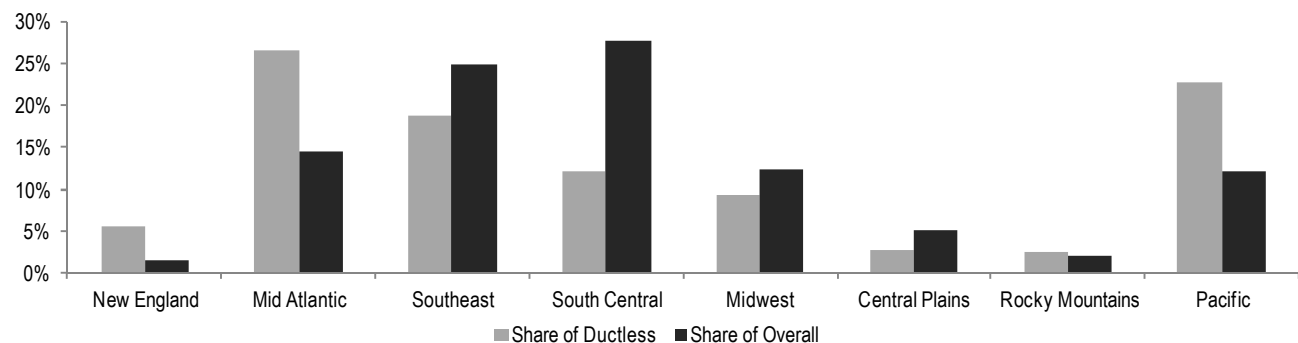
Units, 2019



Source: AHRI, JARN, J.P. Morgan estimates

Figure 282: Residential Mini-Splits Disproportionately Concentrated in Northeast, Mid-Atlantic, and West Coast

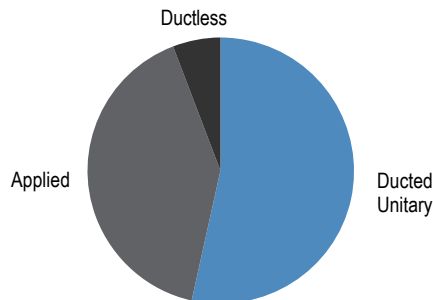
% of AHRI shipments to given region (2009 data)



Source: AHRI, J.P. Morgan estimates

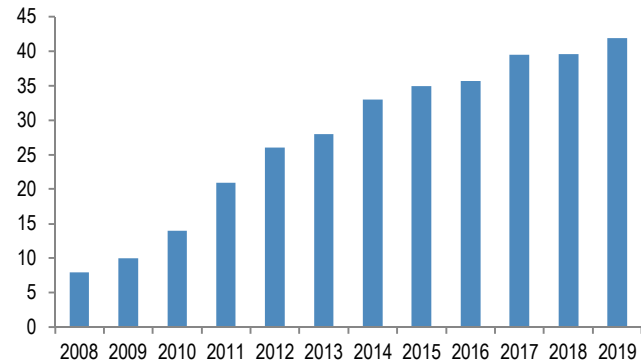
Commercial—We estimate that ductless VRF systems have slightly less than 10% market share of the North American commercial markets, with unitary ~50% of the market and applied in the 40-45% range. According to JARN, the US VRF market grew 5.8% in 2019 to reach 41,900 units. Based on channel checks and company commentary, we think the market is growing at a ~10% CAGR, above the overall market average but not necessarily a disruptive game changer.

Figure 283: Approximate North America Commercial HVAC Market
\$ basis



Source: J.P. Morgan estimates

Figure 284: US VRF Market Units
000s of units



Source: JARN and J.P. Morgan estimates

Outsized growth should continue, but medium-term potential still a TBD

Looking forward, we would expect growth of ductless products to continue to outpace that of the overall industry for the immediate future, gaining share from a low base. The question is where this penetration begins to level out. Based on their standing strategies and commentary, we think most US OEMs view commercial VRF as a more attractive longer-term opportunity, seeing residential mini-splits as somewhat of a niche market.

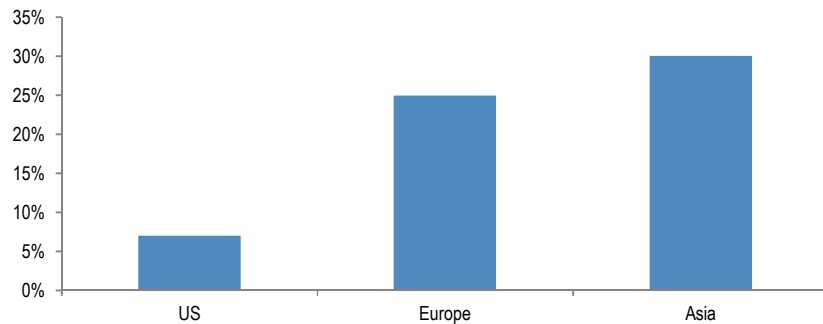
We think residential mini-splits continue to take incremental share but that the US will always fundamentally remain a “ducted” market due to housing preferences.

Residential—Mini-splits have long been popular as a retrofit system as well as a niche product for older homes that don’t have ducts. The question is whether the new construction market adopts, as this is key to broadening the installed base and moving beyond a ~15% market share. The consensus among most industry participants is that material penetration here is unlikely as the US remains a ducted market. However, distributors tend to be more optimistic than the OEMs on the prospect for residential mini-splits in new construction. Our base-case assumption would be that mini-splits continue to gain close to a point of share per year (similar to recent trends), but with penetration beyond the ~15% range requiring a more substantial shift in market preferences.

Commercial VRF likely has greater growth potential if penetration can move closer to Europe/Asia levels.

Commercial—The US penetration of ductless VRF in commercial applications sits at a bit less than 10% versus approximately 25% in Europe and 30% in Asia. While ducted rooftop systems will remain popular in the US, the commercial market probably doesn’t have the same aesthetic hurdles that the residential market faces. While this gap versus Europe/Asia probably doesn’t close long term, we think a double-digit VRF market share is very possible over time.

Figure 285: Ductless Share of Commercial Market Well Below That of Europe/Asia



Source: Lennox, J.P. Morgan estimates

Hybrid approaches like ducted mini-splits a potential solution to expand penetration

As highlighted following last year's AHR Expo, we see the potential for accelerated penetration of the residential mini-split, traditionally a niche product for renovations and multi-family, with most of the recent growth around the commercial VRF. Here, the most interesting product we saw was the Daikin "Fit" line, a potential solution for the replacement market (~80% of industry volumes). This product, introduced this past Fall, offers inverter compressors with cabinet designs that are smaller, lighter, and quieter than traditional unitary outdoor condensing units, and can be installed using existing ductwork and line sets. It's also easier to transport. Mini-splits are more efficient than ducted unitary products, with reportedly better performance, though the hurdle is that the first cost of the equipment is high and no one is going to rip out ductwork, making it expensive versus the baseline lowest SEER replacement unitary condensing unit. However, every regulation that raises the minimum efficiency level, and increases the cost of replacement for the traditional ducted unitary system, brings this equation closer to parity, an opening for players like Daikin/MitsubishiTrane JV, and a threat to the standard unitary "cube." Daikin reps noted that their Fit product is priced in line with a 16 SEER replacement today, and while we think this may not reflect as attractive of a margin for Daikin as the traditional unitary product, the corporate imperative to drive this technology suggests they may be willing to get aggressive in an effort to proliferate penetration.

Competitive Landscape: Asian Players Lead on Technology, JVs and Partnerships; US OEMs Bring Market Expertise

From a competitive perspective, ductless has gone from being a niche product to now being too large to ignore, and Daikin's Goodman acquisition was the exclamation mark on foreign brands' shift into the US. On a medium-term view, assuming ductless at a mid-teens share of the North American HVAC market, we don't see any structural risk for the current leaders; however, it will increase the importance of partnerships with Asian players that will now capture an increasing slice of the industry profit pie.

Ductless space remains dominated by Asian players

As expected, the mini-split market has been historically dominated by the leading foreign ductless OEMs such as Daikin, Mitsubishi, LG, Sanyo, and Fujitsu. Indeed, Japanese manufacturers have led the expansion into NA markets, and are considering M&A opportunities, according to JARN. While there is no publicly available market share data, we believe these players remain the leaders today in the US market with Mitsubishi the largest player. Daikin began designing mini-splits as early as the 1950s and believes it was the first OEM to bring the product to the US, starting in the early 1980s. The US OEMs soon followed as they wanted to offer a complete product line; this had historically been in the form of third-party manufacturing with the systems then privately labeled for US distribution. As we discuss below, this has only recently changed, with US OEMs putting more emphasis on JVs and partnerships in this space.

Foreign brands bring the technology, US players bring channel access and customer support

On a basic level, Asian and US OEMs are natural partners for the North American ductless market as both have distinct advantages. Asian OEMs have the leadership on technology, with years of product R&D and the scale advantage associated with the significant volume of ductless product sold in non-US markets. US OEMs, meanwhile, have the brand recognition and channel access that is critical to reaching distributors, contractors, and design architects, a difficult thing for Asian players to create organically. Although some Asian OEMs have had some success gradually building independent distribution for residential mini-splits, fewer of them have the national presence on the commercial side to support customers in areas like design, planning and specification, or aftermarket service. According to JARN, Asian manufacturers are also targeting the middle-sized building market, avoiding conflict with US firms.

Daikin/Goodman tie-up the most notable industry shift . . .

Daikin's 2012 acquisition of Goodman was the biggest transaction in the HVAC space since Ingersoll/Trane in 2007, and it also represented the most aggressive move yet by an Asian manufacturer into the US market. Indeed, one of Daikin's primary stated goals of the Goodman acquisition was to further proliferate its ductless product into North America. The company now has a much stronger channel presence with the Goodman brand, and this should help Daikin more aggressively market the mini-split/VRF product and overcome the distributor/contractor "buy in" that had been a historical hurdle to ductless growth. Pre-Goodman, Daikin had operated in North America through two different businesses: (1) DACA, its ductless business focusing on mini-splits, and (2) McQuay US, the applied commercial systems business built through acquisition.

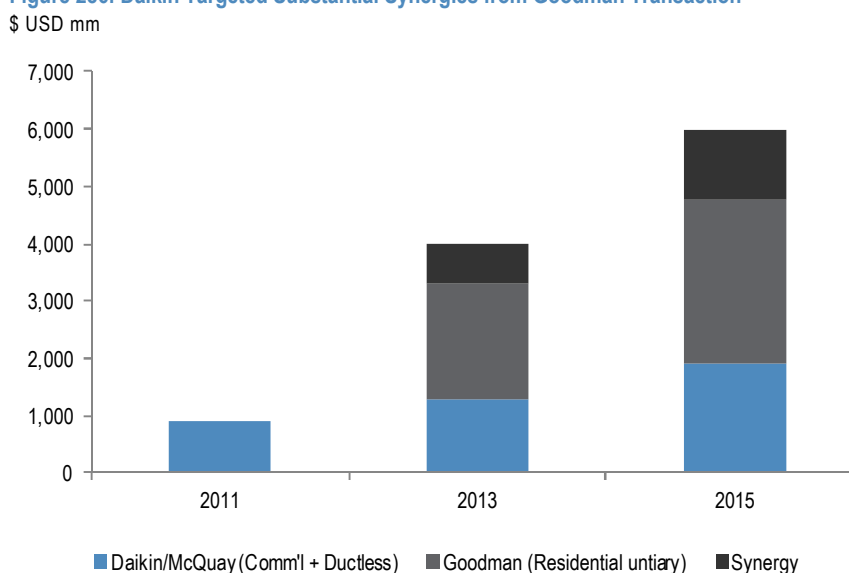
Table 111: Daikin North America Presence (Ex-Goodman)

Annual revenues, \$mm	2009	2010	2011
DACA (ductless North America)	94	134	153
McQuay US (Commercial Applied)	561	644	755

Source: Company reports

In its acquisition presentation, Daikin laid out multi-year revenue targets for its North America business, including fairly robust revenue synergy targets. The presentation suggests as much as \$1B in revenue synergies by 2015, which is substantial but not entirely driven by US mini-split penetration. Other revenue synergies identified by Daikin included (1) increased sales of ducted commercial products in international markets like LatAm and Middle East, (2) more sales of Goodman heating products into overseas markets, and (3) the proliferation of Daikin technology such as compressors and refrigerants into Goodman products.

Figure 286: Daikin Targeted Substantial Synergies from Goodman Transaction



Source: Company presentation

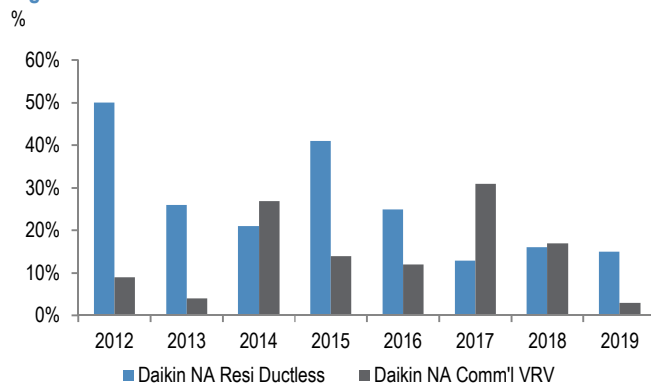
Since then, the company has made steps toward many of these initial goals, including the launch of Daikin premium unitary products and domestic production of the VRV product, both occurring in 2014. The company seems to have acknowledged that its cost advantage has taken it as far as it can, and the announcement to consolidate the North American footprint into a \$400mm mega plant reflects this.

Table 112: Timeline of Major Goodman Integration Goals

Event	Date
Sales of premium Daikin-branded products for non-inverter ducted unitary	April 2013
Sales of Daikin-branded VRV/Rooftop through Goodman network	May 2013
Sales of inverter premium products for ducted unitary	Early 2014
Local production of VRV at Goodman factory	Early 2014
Back office consolidation and integration of Goodman/McQuay procurement	Ongoing

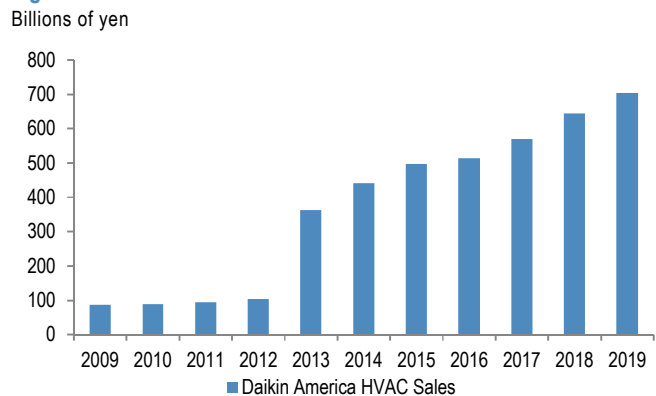
Source: Daikin

Figure 287: Daikin/Goodman North America Ductless Growth



Source: Company reports, J.P. Morgan estimates

Figure 288: Daikin America HVAC Revenues



Source: Company reports

... but partnerships and JVs between US/Asian OEMs now widespread ...

While Daikin is the only Asian player to directly acquire into North America, nearly all the major US players have formed partnerships or JVs with Asian OEMs. We detail some of the major relationships below:

JCI/Hitachi joint venture—In December 2013, Hitachi and Johnson Controls announced a JV under which Johnson Controls assumes a 60% stake in Hitachi's non-Japan HVAC business globally. The JV includes Hitachi's VRF technology, which JCI is introducing to its York channel partners to better serve this market. Outside of North America ductless, the companies also combine what they believe to be complementary commercial chiller technologies as well as distribution channels in key regions like China.

Carrier/Toshiba—Toshiba and Carrier have a history that dates back to the late 1990s, when the two companies partnered for the distribution of Carrier products through various international markets, eventually leading to a joint venture named Toshiba Carrier Corporation. While the terms of the relationship have been re-shuffled over time (Carrier transferred some parts of the JV back to Toshiba in 2008), the two companies began in 2010 to market Toshiba-branded ductless systems through the Carrier distribution channel in North America.

Trane/Mitsubishi—In January 2018, IR/Trane announced that they had entered into an agreement with Mitsubishi Electric (MELCO) to establish a JV focused on marketing, selling and supporting VRF and ductless HVAC systems through Trane, ASD and Mitsubishi channels in the US and LatAm. This is a 50/50 JV comprising

mostly MELCO employees with the CFO from Trane. MELCO is the exclusive provider of commercial VRF, which is effectively everything 3-phase, 6 tons and above, and for residential ductless 5 tons and below, single phase – similar to Daikin's Fit product, they are now building AHUs that connect directly to ducts, opening this part of the market. On end markets, they see about 50/50 Resi/Comm'l (50% which includes some ductless). The JV currently sees \$1 B revenue for FY19, representing ~21% growth versus FY18 with market growth ~12%. They were expecting another significant step up in growth in 2020, and planned to invest to accommodate this growth and build inventory. As background, the JV sells to Trane as the exclusive distributor in certain regions, and Trane records those sales, as well as gross margin, the same as any other product, while the JV is designed to earn a nominal amount of net profit that gets distributed 50/50, all of which is recorded in their operating income. On the Residential side there is growth in the NE and NW stimulating demand with incentives for heat pumps that can serve that market (low ambient heat pumps), and in Commercial the growth is mostly coming from schools and hospitals. VRF is most effective in mid/small high rise buildings, which would fill up incrementally. It is a modular system, without cost in a central plant, and has contributed to a democratized building industry. This dynamic is making mid-scale companies more effective with their offerings and this is where Europe has seen the most demand. The JV was formed after 22 months of negotiation and they feel there is a good cultural fit. So far, first year commercial was better, and second year residential was better. The biggest challenge is that they have stretched their infrastructure radically, as they are a year ahead of the pro-forma and they need to re-engineer supply chain. On VRF competition, Daikin is the fiercest competitor, followed by LG, then Toshiba (with Carrier, which is also with Midea), Fujitsu (with Rheem), and Hitachi (JCI). Coming out of Asia there is good product but the channel is tough. MELCO started 32 years ago, built infrastructure, and invested in training contractors, while others are starting over. Ductless is still 7-8% of total HVAC market, but they believe that it should be 50%+ like the rest of the world and they see this near a tipping point. Looking at Europe, where they are 5-10 years ahead where fossil fuels are being phased out, heat pumps are the only answer for space conditioning and water heating; it will take unique technologies mostly coming from Asia. Prevailing wisdom is that heat pump can't do cold temperatures, but they can do it in new construction projects, where it is high performance, and they have invested in specialist sales force with builders and architects. This is an area where they can take a majority share. In existing homes, however, they are still a small fraction. Most of their residential business is "add-on," not replacement, but replacement is growing. In commercial, VRF is a highly engineered system; Trane is tight with the engineering community and can sell lifecycle cost, and owning most of their own distribution has made the commercial business successful. On margins, MELCO had been spending a lot on marketing and sales, and they have ~200 people; now Trane doing it with ~2,000. Water heating could be a potentially interesting area for them to expand into. MELCO has wide variety of products in this space and they want to bring that over. There is a first cost premium but to aim for an electric economy, they would need to combine heat pump and water.

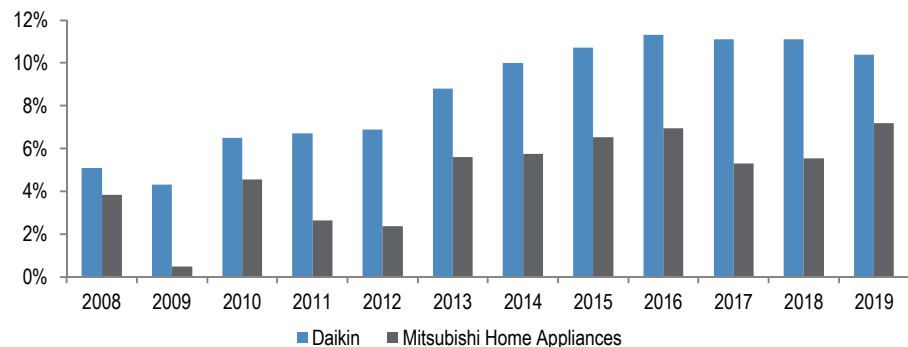
Lennox/Midea—In late 2013, the company announced a multi-year exclusive agreement with Midea (the #1 VRF player in China) to develop a Lennox-branded VRF product to target the North American commercial markets. The initiative has been managed in a separate business unit, with Lennox investing in sales people and engineering support and launched in 2014. Midea manufactures the product under US specs and LII quality control standards, and LII then sells the product through its distribution channel. Lennox had initially targeted revenues of \$100mm from this partnership by 2018, which would've represented >10% of its 2016 commercial HVAC revenues. However, the company has since noted that this may take longer to

achieve from a \$20 mm revenue base currently (\$30 mm as of the 2019 AHR Expo), as it is growing at a slower pace than expected. They had previously forecast the US VRF industry growing from \$445mm in 2016 to \$750mm in 2020.

Margin dynamics are incrementally unfavorable

Additionally, ductless HVAC companies have historically carried lower margins, typically in the single digits even for the industry leaders like Daikin. Some report their HVAC revenues in segments that also include appliances, making it tougher to read exact profitability. This is likely a combination of regional differences (Asian players tend to earn lower margins across many industries) as well as the “retail-like” nature of ductless products that don’t have the same pricing resilience provided by US distribution. For example, Lennox noted in its Midea partnership that the margins are unlikely to be as high as its core unitary product, and with Midea acting as the manufacturer and LII as the distributor, they won’t capture manufacturing margins, but rather see margins around 10%. Also, the JCI/Hitachi JV is around mid to HSD margins currently, in our estimation. Overall, the increase in ductless products is probably slightly dilutive to industry-wide margins, though it may not be hugely impactful to any individual player.

Figure 289: Ductless Players Margins



Source: Daikin, Mitsubishi Electric.

Bottom line: not a game changer, but a more dynamic environment

The growing penetration of mini-split/VRF technology is likely a small incremental negative for the incumbent OEMs but is unlikely to be a game changer as long as ducted systems remain the dominant technology in North America, which we expect to be the case. This is, nonetheless, a significant shift for an industry that has largely kept the same structure for 30+ years. We see a more fluid competitive environment in which partnerships and JVs will be increasingly important to maintaining market share going forward.

Heat Pumps A Growing Part Of The Story

Heat pumps are an energy-efficient alternative to furnaces and air conditioners for climates with moderate heating and cooling needs. Like your refrigerator, heat pumps use electricity to move heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. During the heating season, heat pumps move heat from the cool outdoors into the warm indoor space and during cooling season, heat pumps move heat from the indoor space into the warm outdoors. It is important to note that heat pumps do not generate heat – they simply transfer heat from one place to another with the help of a compressor and refrigerant. Because they move heat rather than generate heat, heat pumps can provide an energy efficient solution to heating and cooling needs at only 25% of the cost of operating a

conventional heating or cooling appliance. Heat pumps are used in both commercial and residential settings. On the commercial side big users of heat pumps include schools, sports facilities, shopping malls and offices. On the residential side, heat pumps are used mainly in single-family homes, but can be specifically used in garages, backyard enclosures and even swimming pools.

Type of heat pumps: Air Source, Geothermal, and Absorption

Air Source — Air-to-air: This heat pump transfers heat between an indoor space and the outside air. Air source heat pumps (ASHPs) have been used for many years in nearly all parts of the US, but until recently they have gone out of favor in areas that experience extended periods of subfreezing temperatures. However, in recent years, advances in air-source heat pump technology now allow this. A study by the Northeast Energy Efficiency partnerships found that when entire units were replaced in the Northeast and mid-Atlantic region, consumers saved 3,000 KWh of energy equating to \$459 a year compared to electric resistant heaters. They can also be used in spaces with and without air ducts, providing flexibility. For example the mini-split heat pump is popular choice among homeowners who have a garage or backyard add-on enclosure that is not connected to main home duct. Modern air-to-air heat pumps can reduce electricity use for heating by approximately 50% compared to electric resistance heating such as furnaces and baseboard heaters.

Air Source — Air-to-water: Air-to-water (ATW) heat pumps vary slightly from their air-to-air cousins. These heat pumps draw in outdoor air and utilize the heat transfer of the refrigerant process to heat water. Here the thermal energy is stored in the form of hot water versus air-to-air heat pumps where the energy is immediately used. These units have the added benefit of providing homeowners with an energy efficient source of hot water, often times eliminating the need for a separate water heater. ATW heat pumps provide the same energy efficiency as air source pumps, however do cost 3-4 times as much due to the addition of the water boiler.

Geothermal: Geothermal heat pumps (GHPs), also known as water-source heat pumps, have been used since the 1940s. They take advantage of the constant temperature of the earth as the exchange medium instead of outside air. While different regions experience different weather climates, a few feet below the Earth's surface the ground remains a relatively constant temperature, allowing geothermal heat pumps flexible use during the summer and winter months. Like the name suggests, these pumps transfer heat from water-to-water. Geothermal heat pumps can reduce energy use by 30-60%, control humidity, are reliable, and fit a variety of homes. A major downside of these pumps is that they are expensive to install, typically 5-6 times the cost of an air-source system and those costs are not returned to the consumer until 10 years.

Absorption: Absorption heat pumps are essentially ASHPs driven not by electricity, but by a heat source such as natural gas, propane, or solar heated water. Because natural gas is the most common heat source, absorption heat pumps are commonly known as gas-fired heat pumps.

Comparison to traditional AC

Heat pump technology has been around for decades and is commonly used in the US because of its energy efficiency and less reliance on natural gas. However it is important to understand the strengths and weaknesses of these systems relative to traditional AC units. This is in the context of residential application but apply to commercial as well. As we show below, the cost of heat pumps (2-3x that of a combustion-type boiler) is probably the biggest deterrent to their widespread adoption, with the biggest drivers of demand being environmental regulations and

government subsidies, something seen across many areas of Europe (e.g., France, Germany), and perhaps to come in the US under a Biden Administration.

Strengths of heat pump technology include:

- **ASHPs are efficient** – Air source heat pumps have high efficiencies compared to other heating and cooling technologies, meaning they use less fuel to heat a home or business than conventional AC. Over time, consuming less energy can help reduce energy bills and environmental impact.
- **Health and Wellness benefits** – ASHPs operate relatively quietly. This is particularly true for ductless mini-splits. While dishwashers and AC units typically run at around 60 decibels, many ASHPs operate between 40-60 decibels and ductless mini-splits as low as 20 decibels. Air quality also is improved as heat pumps provide humidity control, dehumidifying the air during summer months.
- **ATWs are a one-stop shop** – ATW heat pumps provide the added benefit of providing heating and cooling solutions in air as well as heated water, eliminating the need for the consumer to purchase a separate water heater.
- **Safer than gas** – Gas furnaces have the added safety concerns of leaks or even fires, both of which are not a concern for heat pumps.

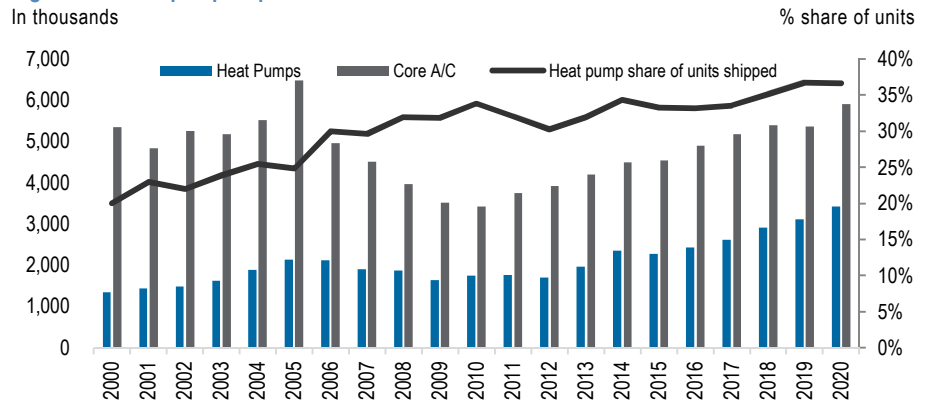
On the flip side, weaknesses of heat pump technology include:

- **Higher installation costs** – The cost of installing a heat pump varies upon a number of factors including the quality of the equipment, type of heat pump (ATA or ATW), ducted or ductless, etc. All else equal ducted air source heat pumps can cost \$12,000 to \$15,000 per home, while ductless systems cost around \$3,500 to \$5,000. Gas, electric, and oil furnaces, on the other hand, typically cost less than \$5,000 to install.
- **ASHPs may increase your heating costs** – While ASHPs use less energy and can help many consumers save on heating bills, this is not true for everyone. Remember, heat pumps require electricity to operate. This means that even if you use less fuel overall to heat your home with heat pumps, consumers may end up paying more on energy bills if the cost of electricity is significantly higher than fuel costs.
- **Cold weather** – Heat pumps tend to be less efficient in extreme weather. Because they rely on using heat from the air or the ground, they lose efficiency during extreme cold snaps when there is little extra heat to be found.

Market dynamics in the US show air-source heat pumps gaining share in resi, ATWs still with low penetration

According to AHRI, the air-source heat pump market in the US was 3.1 million units in 2019 and up to 3.3 million units on an LTM basis through October 2020. Heat pump sales have been increasing steadily the past 10 years, growing 8%, 12%, and 6% the past 3 years.

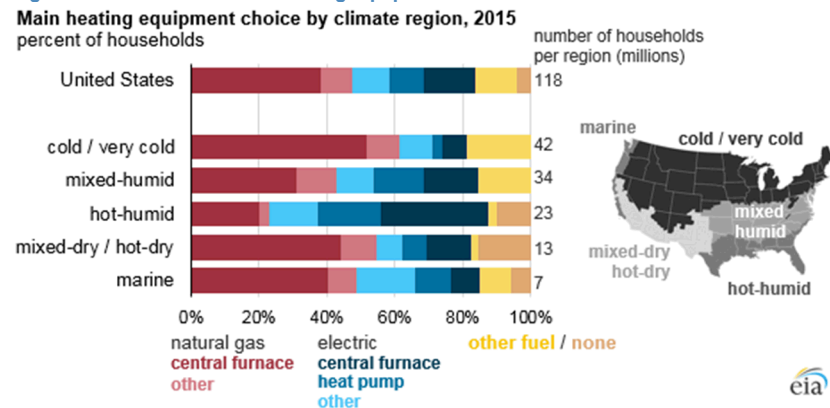
Figure 290: Heat pump shipments in the United States



Source: AHRI

Meanwhile, the US market for ATW heat pumps was 101,200 units in 2019, according to JARN. The annual sales volume of residential water heaters is large at roughly 8 to 10 million a year, potentially providing a tremendous growth opportunity for ATW heat pumps over time. Furthermore, swimming pools represent a large growth opportunity in the US, given over 10 million residential swimming pools in the US, which require hot water that can be provided by heat pumps at 2/3 of the energy compared to traditional systems. The primary reasons for the low adoption rates in the US is that heat pumps are competing with boilers that are cheaper to install and operate with inexpensive natural gas.

Figure 291: US household's heating equipment choices are diverse

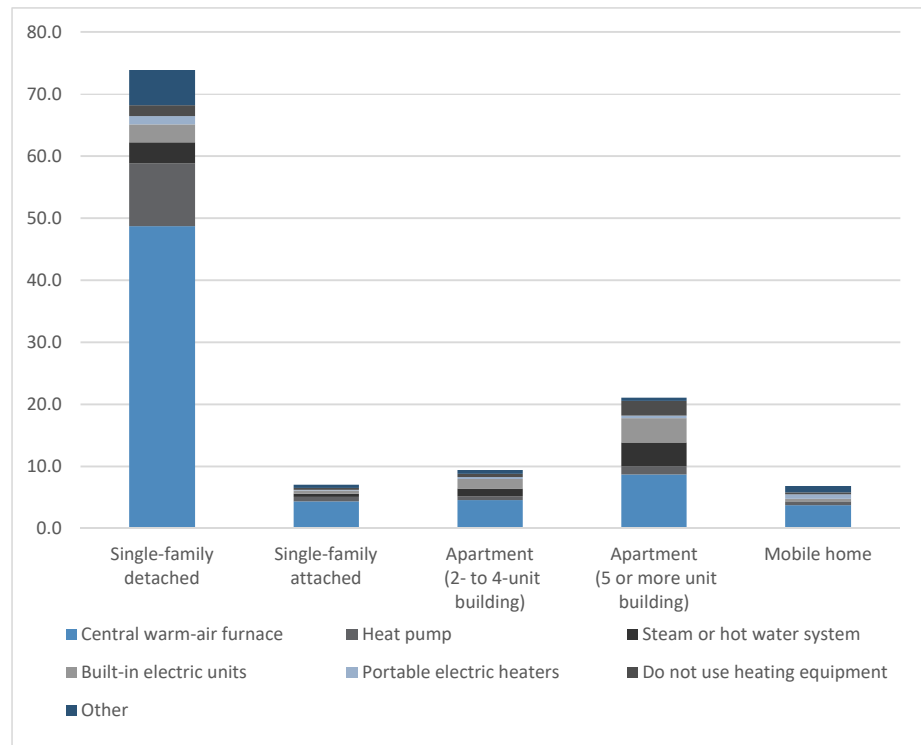


Source: US Energy Information Administration

US consumer demand for heat pumps vary significantly by region which is currently a limitation. However, as investments are made in heat pump technology their use in colder regions will grow. In 2015, there were 13.4 million households that used heat pumps as their main heating equipment up from 9.8 million in 2009. Relative to central air furnace, which heated 70.1 million homes in 2015 in the US, heat pumps have small market share.

Figure 292: Space heating in U.S. homes by housing type, 2015

in millions



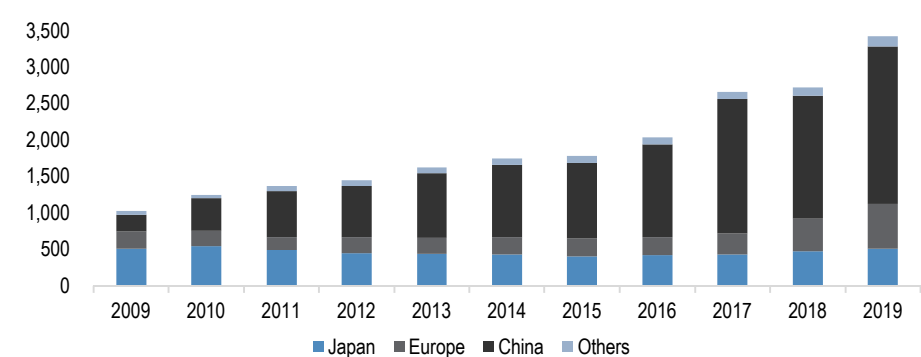
Source: US Energy Information Administration

International markets: Europe/Asia showing strong uptake of heat pumps

Global markets have seen rapid adoption of ATW heat pumps, driven by increased focus on environmental benefits and government subsidies, including coal to electricity policies in China and the phase out of oil-fired boilers and low efficiency gas-fired boilers in Europe. According to the JARN, the global market grew 28% in 2019 to 3.42 mm units, and has grown at a low-double-digit % CAGR over the past ten years, driven by China and Europe.

Figure 293: ATW heat pump shipments worldwide

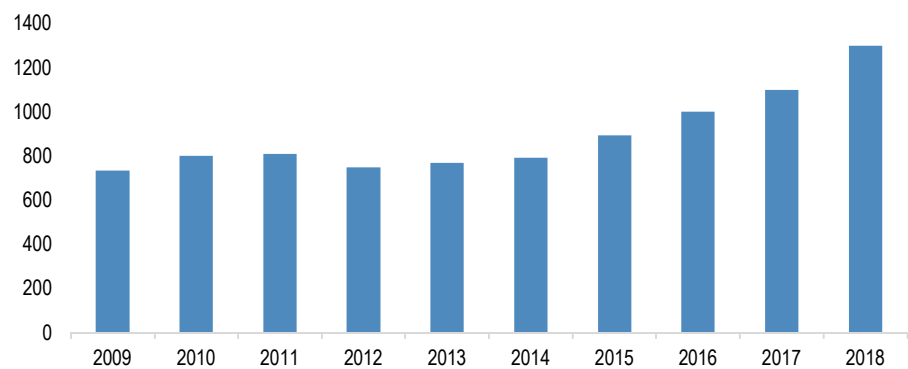
in thousands



Source: JARN

JARN estimates that the European ATW heat pump market reached 618,600 units in 2019, growing 36.8% year over year. Of this total, France accounted for 47.4% of the ATW market. Germany and Italy combined account for 20% of the market. European heat pump demand is growing rapidly because of policy of moving towards decarbonization. Rapid growth there is primarily attributed to their effort to phase out old combustion-type boilers in order to reduce CO2 emissions, a trend expected to continue into the future, according to EMR. Many countries around the world plan to include heat pumps in renewable energy categories to promote their development as they begin to phase out old combustion-type boilers. Furthermore, by offering subsidies and restricting the application of fossil fuel boilers on new systems, heat pump demand remains strong. Although Europe has not seen much economic growth since 2015, heat pumps have enjoyed double-digit growth for the past 5 consecutive years. A big driver for this was the Paris Climate accords passed in 2015. According to the EHPA, the overall heat pump market in Europe is large and growing rapidly. In 2018, Europe saw 1.3 million units shipped, up from 1.1 million units in 2017. There are more than 11 million heat pumps units now installed in Europe, as the technology has quickly developed into a cornerstone of Europe's heat supply, with a leading position in France, followed by Italy and Spain.

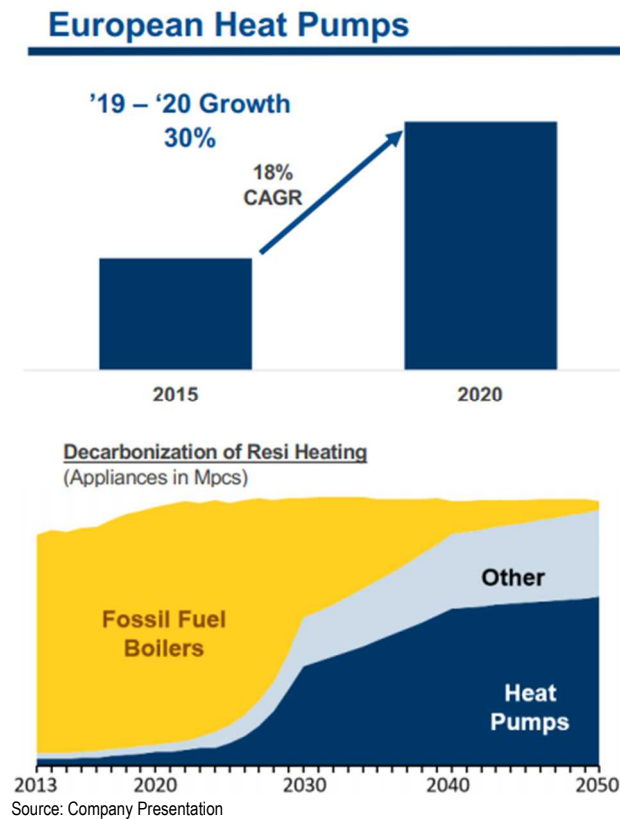
Figure 294: Heat pump shipments in Europe
in thousands



Source: European Heat Pump Association

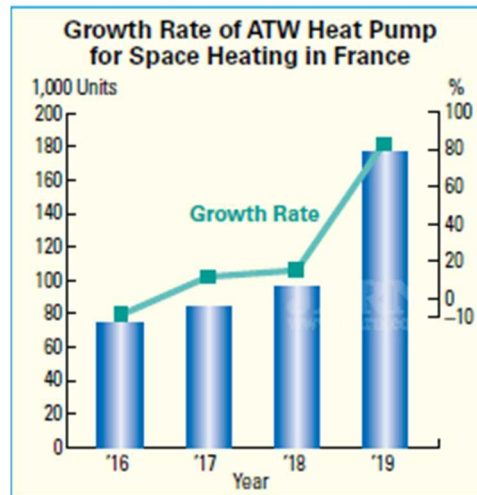
Figure 295: Emerson European heat pump and future growth projections

Mpcs



JARN estimates that France is the largest ATW heat pump market in Europe with over 176 thousand units sold in 2019, up 83% from 2018. Sales are primarily residential with new and replacement split 45% and 55%, respectively. France ATW market has grown tremendously over the past 10 years and now developed into a replacement market. The current subsidy and tax credit policy environment in France has led to widespread adoption of ATW heat pumps. Starting in 2020, French low-income households can receive a benefit of funding up to 8,000 EUR while medium-income households will be able to receive a benefit of up to 3,000 EUR.

Figure 296: ATW heat pumps sales in France
in thousands



Source: JARN database, Uniclimate

Figure 297: Tax Credits for heat pumps in France

Tax Credits for Heat Pump Installations in France

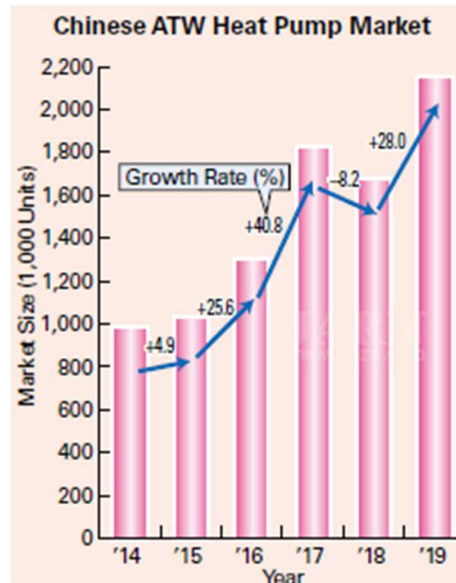
Heat Pump Type	2014	2015	2016	2017	2018	2019
ATW	15%	30%	30%	30%	30%	30%
GSHP	15%	30%	30%	30%	30%	30%
HPWH	15%	30%	30%	30%	30%	30%
ATA	Incentive program concluded in 2008					

Source: JARN database

As for Asian regions, Japan has a mature ATW heat pump market that has a long sales history. According to statistics from JRAIA, Japan's ATW heat pump market in 2019 reached 510,159 units, up 7.3% from 2018. Japan was one of the first countries to deploy ATW heat pump technology, and has accumulated a lot of technological experience on heat pumps and heat energy storage solutions. Demand in the Chinese market has continued to be robust, reaching 2.15 million units in 2019, an increase of 28% from 2018. Australia, which has some of the strictest environmental regulations in the world, is another growing market for heat pumps. However, there are many developing countries in Southeast Asia that are not yet adopting the technology.

Figure 298: Chinese ATW heat pump market

In thousands



Source: JARN database

Market Players Include Traditional A/C Makers in US and Varied OEMs Abroad

In the US, the major players in resi A/C all provide heat pump products, as well as companies like A.O. Smith that make water heaters. Elsewhere, with market expansion in Europe, the supply chain for ATW heat pumps has been expanding. European boiler manufacturers have entered the heat pump sector by starting to produce and sell ATW heat pumps. Japanese manufacturers are speeding up localized production. Currently, Daikin, Johnson Controls-Hitachi Air Conditioning, Mitsubishi Electric, and Panasonic have ATW heat pump production bases in Europe.

European Manufacturers: European boiler makers such as Vaillant and Viessmann have invested heavily in heat pump development. This is important as they may be noticing less demand for boilers as heat pumps serve a dual purpose and are realigning their strategy. German local manufacturer Stiebel Eltron is also a strong player in the space with a longstanding history that has gained market share recently.

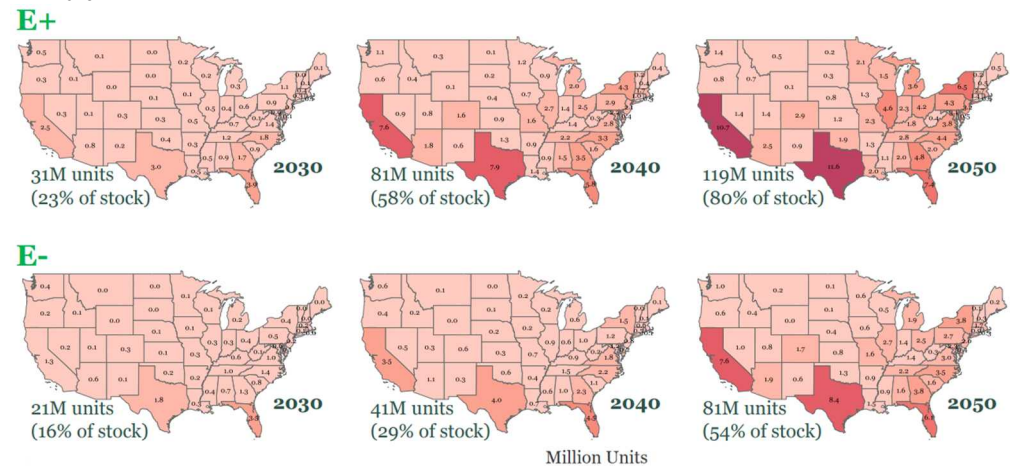
Asian Manufacturers: Japan has long reigned on heat pump manufacturing and technology. Daikin has been producing ATW heat pumps in Belgium and the Czech Republic for many years. Mitsubishi Electric has production facilities in Scotland and Johnson Controls-Hitachi has a production site in Spain, and Toshiba Carrier plans to start production of heat pumps in its production base in Europe by the end of 2020. Daikin and Mitsubishi hold 50% market share in Europe combined.

Europe and Asia taking advantage of heat pump energy efficiencies, how will this impact US demand?

While the US is currently not in the Paris Climate Accord, although may soon be under a Biden administration, many states have set their own goals to cut greenhouse gas emissions in an attempt to still comply with the Paris accords. For example, CA wants to be carbon neutral by 2045, NY is aiming for a 100% cut from 1990 emissions by 2050, and FL has committed to an 80% reduction in emissions by 2050. Scaling up heat pumps hold a lot of promise for curbing climate warming emissions. In a 2018 study prepared for the Natural Resources Defense Council, researchers estimated that switching to heat pumps for space and water heating could cut emissions from California households in half. Most importantly, policy makers in Washington know this. [The United States Mid-Century Strategy for Deep Decarbonization](#), an official document from 2016 laying out how the country would meet the Paris Agreement (before Trump administration withdrew the US from the agreement), specifically mentions heat pumps as part of the strategies for reducing emissions from buildings.

While the Biden administration has made it a priority to rejoin the Paris Agreement in the President's first 100 days, the administration also has a clean energy plan of its own. As part of its 2 trillion dollar infrastructure plan, the administration wants to achieve net-zero emissions, economy-wide, by no later than 2050. Princeton University has recently completed a [detailed study](#) of what it would take for the US to achieve this task and heat pumps play a major role. Priorities for 2030 are to increase by more than double the share of electric heat pumps for home heating to 23% vs. 10% today and triple the use of heat pumps in commercial buildings. Under the most ambitious scenario the plan calls for 80% market share with 119m units, while the less aggressive end-use electrification model calls for 54% market share and 81 million units.

Figure 299: Residential heat pump grow in Princeton study under 2 scenarios
in millions



Source: Princeton Environmental Research

Primer I: The Basics of HVAC Technology

This section provides the basics of HVAC technology and the terminology of the related products, key to understanding our later discussion of the competitive landscape.

Cooling Basics

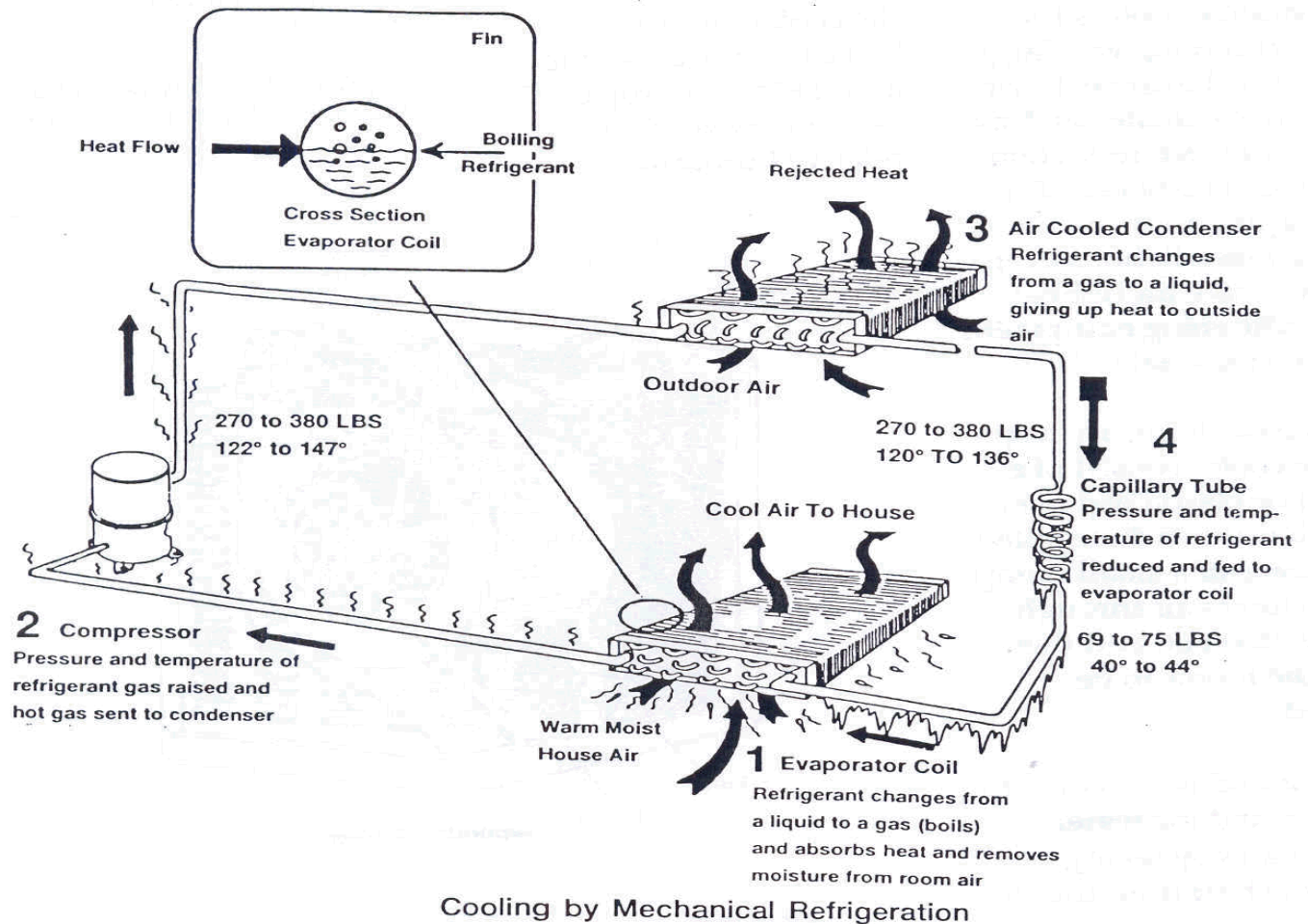
While some materials and components used in HVAC have changed over the past several decades, the basic technologies involved have remained pretty much the same. A/C systems utilize two distinct processes: vapor compression and absorption. In the vapor compression systems, a heated substance, usually air from an interior space, is exposed to a refrigerant. The difference in thermal energy between the two substances causes heat in the air to flow from the interior to the refrigerant. This exchange cools the air, which in turn cools the interior space when it is pumped back to the interior space. Absorption systems utilize the fact that liquids or salts can absorb vapor from another fluid. The most common fluid used in these systems is water with a salt compound. Compression is achieved thermally in a system that involves a solution pump, generator and an expansion valve, rather than using a mechanical compressor.

The vapor-compression refrigeration cycle

The cooling cycle used in most AC equipment, including residential applications, involves four major steps:

1. *The evaporator coil*—The actual process of cooling occurs here, where refrigerant changes from a liquid to a gas (boils), in the process absorbing heat from the air and reducing the indoor temperature. The key to this process is that refrigerants boil at a lower than normal temperature. When air is cooled by passing through the evaporator coil, much of the water vapor in the air condenses into a liquid on the fins and tubes of the coil. Most of the liquid water formed on the fins and tubes of the evaporator drips down into the drain pan. It is usually disposed of through a condensate line leading to a floor drain or to the outdoors.
2. *The compressor*—Two functions are performed by the compressor. First, it pulls the refrigerant gas out of the evaporator. Second, it compresses the gas to a higher pressure and, in the process, raises the temperature of the refrigerant gas. The refrigerant might enter the compressor at, say 61° F and at a gauge pressure of 75 psi. The compressor squeezes the vapor and increases its pressure to perhaps 295 psi with an accompanying increase in temperature to 195° F.
3. *The condenser*—The hot, compressed refrigerant gas leaving the compressor moves into the condenser. Here, the hot refrigerant gas now gives up heat and condenses back into a liquid with little change in pressure. Outdoor air is usually used to “cool off” the hot refrigerant. If that is the case, it is called an air-cooled condenser. Outdoor air, even at a temperature of 100° F, is much cooler than the refrigerant gas, which might be at 130° F inside the condenser. The air removes enough heat from the gas to make it condense back into a liquid state so it can begin its trip back to the evaporator to start the cycle all over again.
4. *The restrictor and capillary tube*—Even when the refrigerant comes out of the condenser, however, it’s still too hot to deliver any cooling at the evaporator coil. Therefore, the system undergoes a vapor compression system to reduce the temperature. This occurs through a small-diameter capillary tube, a restrictor, and a thermal sensor, which detects changes in the refrigerant temperature and opens the valve for the refrigerant to flow out.

Figure 300: Mechanical Refrigeration Cycle



Source: HARDI, used with permission

Measuring cooling capacity

Cooling capacity of equipment is measured in terms of the amount of sensible and latent heat extracted over a certain period of time. This could be described in terms of Btu per minute, per hour, or per 24 hours. The cooling capacity of an air conditioner, however, is usually reported in terms of a “per hour” basis, such as 24,000 Btu/hr. The term “ton of cooling” is still widely used as a measure of cooling capacity. A ton of cooling is the number of Btu required to change a ton (2,000 pounds) of ice at 32° F to water at 32° F in a period of 24 hours (12,000 Btu/hr equals one ton of refrigeration effect).

What is a heat pump?

A heat pump is a piece of equipment designed for both heating and cooling use. Heat pumps generally use the same principles as we describe above, transferring the heat of indoor air to the outdoor air. A heat pump also reverses this process. It brings heat extracted from the outdoor air inside to warm room air. For this reason, heat pumps are more prevalent in warmer regions such as the South, because its heating efficiency declines in colder temperatures. The change from cooling to heating and vice versa is accomplished by an automatic “reversing” valve that directs the flow of refrigerant leaving the compressor between the two coils. Water-source heat pumps use water to transfer heat from the refrigerant, while air-source heat pumps use air movement over coils to accomplish the transfer of heat. Because the function of each coil changes between heating and cooling, it is customary to refer to the coils as the indoor coil (or section) and outdoor coil (or section) rather than simply an evaporator or condenser.

Chilled water systems

An alternate method for cooling is a chilled water system. In this method, the chilled water is circulated by means of one or more pumps to vertical or horizontal fan-coil units. Each terminal unit is equipped with its own blower and filtering system to circulate room air over the cold pipes and the cooled air back into the room. The same piping system could also be used to circulate hot water for heating. The advantage of chilled water is the ability to conveniently route small pipes through building construction, provide local temperature control and have the efficiency associated with a single central cooling unit. As we describe later, chilled water systems are generally used for large commercial, or “commercial applied” systems.

Residential Cooling Applications

While all residential systems use essentially the same types of technology, there are several ways to deliver the chilled air, each requiring slightly types of equipment.

Traditional split system

The most common form of residential central air is a “split” system, representing over 85% of residential installations. It consists of two packages: the evaporator section mounted indoors, and the compressor-condenser section, mounted outdoors. It is necessary to connect the two sections with refrigerant lines and to run electric power supply and control circuits to both sections. In most cases it would be connected with an indoor furnace, which would share the same duct system and provide heating during the winter.

Figure 301: Central AC Split System with Furnace



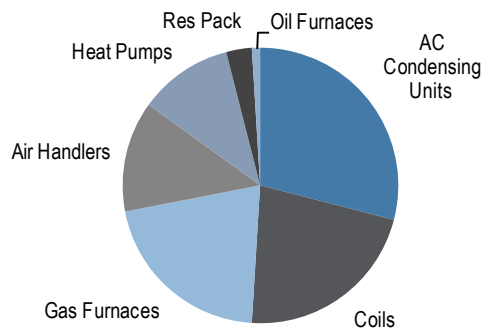
Source: York, used with permission

Therefore, a split system would require the purchase of several pieces of equipment:

- *Condensing unit or heat pump*—This is the “outdoor unit” tracked by AHRI shipments, named for the condensing process that occurs within it. The outdoor unit would include components such as a compressor and a motor.
- *Coil/line set*—This is the indoor unit needed to deliver the cooling, as well as the metal pipes to carry the refrigerant from the outdoor condenser into the house.
- *Furnace*—Purchased separately, and can be fueled by either oil or (more typically) gas. A heat pump would generally not require a furnace. The furnace will often contain a blower with which the cold air is distributed.
- *Air handler*—An air handler is installed inside the house and designed to distribute cool air through the house via the ductwork. This is typically required when there is no furnace.

All of these components would be sold by the major HVAC OEMs. The chart below from Lennox provides an estimate (on a unit basis) of the different types of equipment sold. Condensing units and heat pumps are still the largest component of equipment sales (both on a dollar and unit basis) as they can often be replaced on their own while keeping the existing coil, furnace, and air handler. In a full-system changeout, however, a homeowner would need to also replace most of the indoor system. This is a key point in understanding the R410A refrigerant transition as the coil and line set of an older R-22 system would not be compatible with an R410A condenser and therefore would require replacement.

Figure 302: A/C Equipment Market Breakout (Units)



Source: LII company reports.

Packaged cooling systems

Some residential applications have what is called a “packaged” or “all-in-one” system, which uses the same technology but in just one box rather than split between an indoor and outdoor unit. Combined in a single package are the motor-compressor, condenser, evaporator, controls, a blower for circulating room air through the evaporator, and a fan assembly for circulating outdoor air through the condenser. This unit could then be connected to the ductwork. These are packaged and sold by the major OEMs and would show up in the condensing unit shipments, but (per the chart above) represent a smaller percentage of industry sales.

Ductless mini-split

Mini-splits can be thought of as a combination of a ducted split system and a window/room AC unit. Like split systems, the condensing unit sits outside with pipes that pass the refrigerant between the outdoor unit and the indoor coil. For this reason, they require a licensed contractor to install. Unlike splits, however, the mini-split does not use ducts and instead has one or several indoor units providing cooling just to one specific room.

Figure 303: Mini-Split Indoor Unit



Source: Company reports, used with permission

Figure 304: Mini-Split Condensing Unit



Source: ACHR, used with permission

Ductless Window or room air

Window or room air conditioning is ductless equipment and is a small, self-contained system that houses a coil and a compressor usually used for the cooling of a single room. These products are more commoditized, dominated by low-cost producers, and don't require a licensed contractor to install.

Commercial Cooling Applications

There are two primary types of commercial cooling applications, unitary and applied, while ductless mini-splits are also used.

Commercial Unitary (“light commercial”)

A unitary product is generally used for smaller commercial buildings of three stories or less. It is useful to think of this as simply a large residential system as the technology is essentially the same: if the evaporator coil is enclosed in the same casing as the condensing unit, it is referred to as a “self contained” or “single” package unit, while in a “split” system, the evaporator is in a separate casing and connected to the condensing unit by tubing. Capacity of this equipment ranges from 5 to 120 tons (though the higher concentration is between 5 and 15 tons). Light commercial units would typically sit on the rooftop of a commercial building.

Figure 305: Light Commercial System



Source: Carrier, used with permission

Commercial Applied (“large commercial”)

An “applied” system would be a larger system with a large chiller and then a complex set of equipment that is custom engineered for a particular building. These are more commonly used for large commercial/institutional/industrial properties. It is helpful to think about the system in two parts, the chiller and the related equipment. Chillers are sold by all the major OEMS such as Carrier, Trane, Lennox, Daikin/McQuay, and York. Applied equipment is sold by a combination of those players and other third-party suppliers.

- *Chillers*—Chillers come in two forms: air cooled and water cooled. Air-cooled chillers are used in outdoor applications and have large fans to force outdoor air through the system, while water-cooled machines are designed for indoor use and are supplied by water for condenser heat reaction. This large equipment works by compressing large volumes of refrigerant gas that is then circulated through a condenser to cool water. The chilled water is then pumped to coils over which air is passed to provide cool air to the conditioned space. The condenser water is kept cool by a cooling tower. The units are typically installed in a basement area, though they can also be installed on a roof, next to the facility, or even in a separate chiller plant. The equipment is more commonly found in larger buildings and involves a highly technical installation, starting at 50 tons of cooling capacity, all the way up to highly engineered systems that use 5,000-10,000 tons. Generally speaking, products of ~50 tons are referred to as middle-market products, while larger tonnage equipment starts at around 250 tons.

Figure 306: Large Commercial Chiller



Source: York, used with permission

Figure 307: Chiller Installed



Source: Grinnell College, used with permission

- *Applied equipment*—This consists of configured-to-order systems that consist of individual components, such as compressors, condensers, evaporator, motors and controls. These are selected, matched, and then assembled at the customer site. These systems also have ventilation components such as air handling units, fans, ventilators, humidifiers, and de-humidifiers. Frost and Sullivan has estimated that these costs represent ~20% of the total applied system cost, while Trane has said that the airside portion of an applied system job can range from ~20% by value for a smaller one to ~60% for large ones. This equipment is key to the more complex systems that can cool multiple, independent zones on several thermostats. A cooling tower on the roof of the building would also typically be required for water cooled condensers, as described above.

Ductless applications

On the ductless side, mini-splits are a common type of air conditioning used in commercial application. The technology and application is the same as residential, with an outdoor condensing unit connected to any number of indoor wall units. They are common in light commercial applications internationally, particularly in Asia, and with more limited but growing use in the US.

Primer II: HVAC Market Overview & Summary of Key Players

Having described the different types of technology and application work, this section provides an overview of the HVAC market. This includes market size, key players with share, business mix and end markets, and sales channel for each of the major sub-segments of equipment.

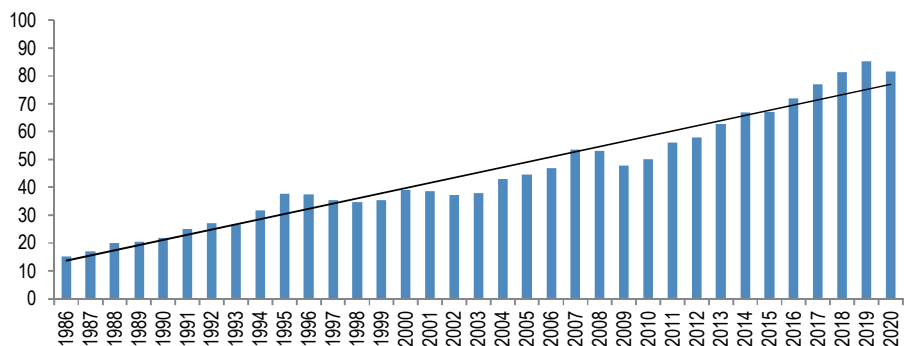
Global Market Overview

The global HVAC market, as globally defined, is generally less significant given the wide range of applications.

We estimate the global HVAC market at ~\$147B in 2020, which is inclusive of all related equipment, services, and systems/controls. This broad market definition, however, is less useful given significant differences between the various subsectors of the global industry. Indeed, with the possible exception of Daikin, none of the OEMs is a major player of size in this entire \$100B+ opportunity. Therefore, we think it is instructive to break this down into several parts. We divide the market into two major sub-segments: equipment (~55% of industry revenues) and services (~45%). We break down the equipment into large commercial (applied/chillers), light commercial (commercial unitary or ducted), residential (residential unitary or ducted), and appliances/other (ductless equipment for both residential and commercial markets). The aftermarket, which includes parts and services, also represents a major revenue stream that we estimate at about \$66B.

Figure 308: World HVAC Equipment Market

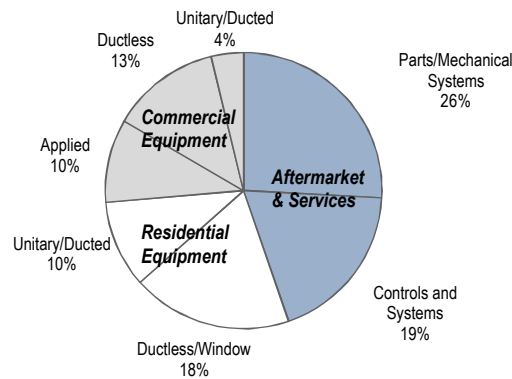
\$ in billions



Source: Carrier and J.P. Morgan estimates.

Figure 309: Global HVAC Market (~\$147 billion)

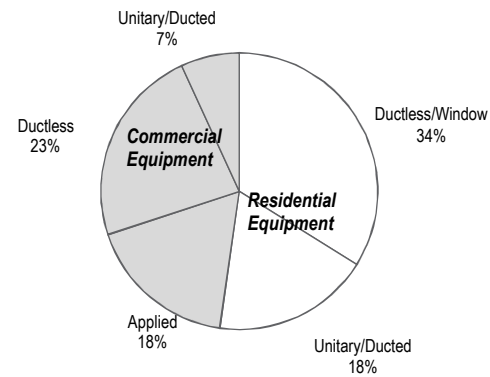
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Figure 310: Global HVAC Equipment Market (~\$81 billion)

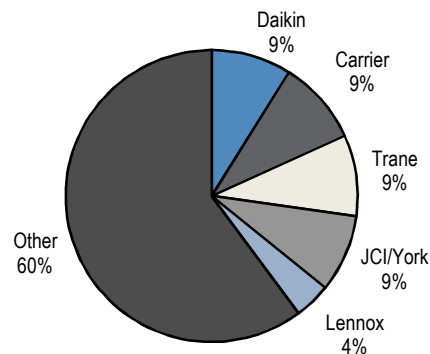
% of 2020 Industry Sales



Source: J.P. Morgan estimates

Key players in the industry include Carrier (division of United Technologies), Trane (division of Ingersoll-Rand), Daikin (including Goodman and McQuay), York (a division of Johnson Controls), Lennox, Rheem, and Nordyne. Beneath the OEMs, and not included in this chart, is a layer of component suppliers including compressor manufacturers (i.e., Emerson's Copeland unit, Danfoss and LG) and motor makers such as Regal Beloit.

Figure 311: Total HVAC Equipment Market (~\$81B)



Source: J.P. Morgan estimates.

Keep in mind that although the industry appears fragmented globally, much of this reflects the large size of the ductless/window AC market in which the major US OEMs like Carrier and Trane have limited participation. Specific sub-segments tend to be more consolidated with a handful of major players, and the table below provides a basic overview of the major categories and which companies participate where.

Table 113: Summary of Key Global Players

Commercial			Residential			
Applied (Large)	Unitary (Light)	VRF (Ductless)	Unitary (Central A/C)	Heat Pumps	Ductless Mini-Splits	Window/ Room
York	York	Mitsubishi	Carrier	Carrier	Mitsubishi	LG
Carrier	Carrier	Daikin	Daikin/Goodman	Daikin/Goodman	Daikin	Fedders
Trane	Trane	Toshiba	Trane	Trane	Toshiba	Haier
Daikin/McQuay	Lennox	Hitachi	Lennox	Lennox	Hitachi	Whirlpool
Dunham-Bush	Daikin/McQuay	Gree	Rheem	York	Gree	Electrolux
Gree	AAON	LG	York	Rheem	LG	
Midea		Fujitsu	Nordyne	Daikin	Fujitsu	
Ebara		Samsung			Samsung	
		Trane				
		Lennox				
		Carrier				

Source: Company reports. Note: Order of companies does not correspond to market share position.

Residential Products and Manufacturers

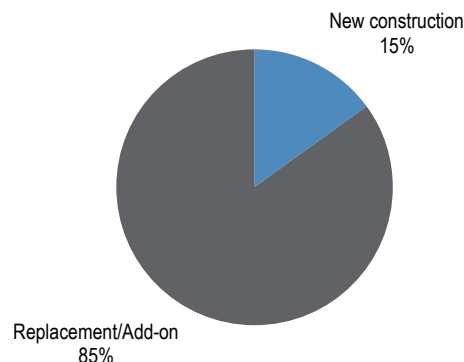
As we described in previous sections, several types of equipment are used in the residential heating & cooling marketplace. Broadly speaking, however, cooling applications can be broken down into two primary forms: ducted (a.k.a. “central AC”) and ductless (which includes mini-splits and window units). On the heating side, we walk through the furnace market (primarily powered by gas or oil), though cooling and heating can also be done by a combined heat pump product. We estimate that the centralized (ducted) A/C and heating market is ~\$15B in size globally, almost entirely in the US. The remainder of the residential market is ductless products, either standard splits, mini-splits/multi-splits, or window and room air conditioning units—these areas are less of a focus of this report outside of a small emerging opportunity in North America.

Residential Unitary (Central A/C) Equipment (~10% global industry revenues)

We estimate that the residential unitary HVAC equipment market (a.k.a. ducted or central A/C) is ~\$15B, or ~10% of industry revenues. This is the space most dominated by US OEMs such as Carrier, Trane, and Lennox, along with Daikin. The residential unitary product is heavily U.S. centric as North America is one of the few regions globally where ducted homes are the standard (most of the international installations are in ductless form). Residential unitary products are installed by licensed contractors and generally sold through a “two-step” distribution process.

Demand drivers—Sales come from both new installations and replacements. Historically, replacements have made up ~75% of condensing unit sales, but with the sharp drop in housing starts and somewhat sluggish recovery in recent years, this number has moved to ~85%. When we include other products such as indoor units and coils, the mix of overall equipment sales is closer to ~20% new construction. Systems typically last between 10 and 20 years, depending on the region and the intensity of use. Cyclicalities in replacement occurs less frequently than in new installation given its lower reliance on new construction, though exposure to weather trends makes the demand outlook less certain in the short run.

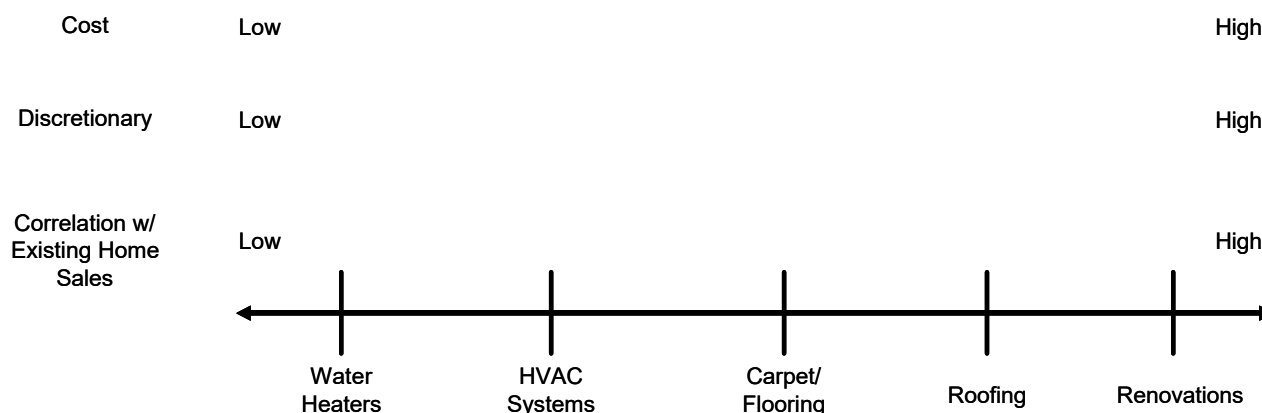
Figure 312: Breakout of US Residential Unitary Market (Condensing Units)
2020



Source: AHRI and J.P. Morgan estimates.

Short-term discretionary, long-term necessary—To better understand the dynamics of the core heating and cooling equipment replacement markets, we have compared the decision to replace a system with that of other key household durable goods products, such as water heaters, carpeting, and roofing. Our conclusion from this analysis is that water heaters are, not surprisingly, the least discretionary of all items (as an executive at A.O. Smith once said at our HVAC conference, “You only need to take one cold shower before you replace your water heater”). Next on the list, based on our analysis, is an HVAC system, which we think is a discretionary expense in the short term but will ultimately be replaced in the long term. This is because HVAC systems provide an element of comfort to a homeowner that most people find essential, similar to that of a water heater, though often not quite as urgent.

Figure 313: Residential Durable Good Replacement Map



Source: J.P. Morgan

This can also be seen in terms of correlation with existing home sales. What we found was that, not surprisingly, water heaters have the lowest correlation, at 55%, while roofing has the highest, at ~80%. HVAC and furnace system replacements have the second-lowest correlation, at ~60%, implying that these systems do tend to get replaced by existing homeowners for purposes of their own personal comfort, not just during turnover. They have also outperformed other housing-related consumer goods like carpeting and appliances, a point we discuss later.

Table 114: HVAC Replacements Only Partially Correlated with Existing Home Sales

Correlation % with Existing Home Sales

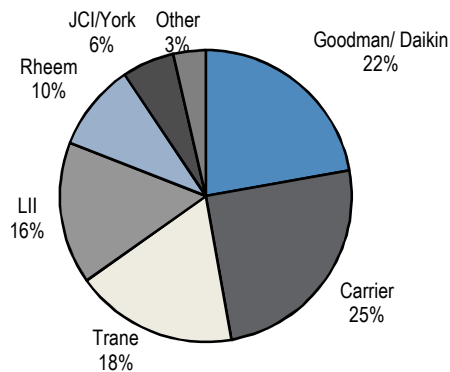
Product	Correlation %
Water Heaters	55%
HVAC/Furnace Replacements	60%
Carpeting	80%
Roofing	80%

Source: J.P. Morgan estimates

Key players and market share —From a market share perspective, we estimate that the top six players continue to represent ~90% of total industry sales, and >95% of the NA market. Carrier and Goodman remain the two largest players, by our estimates, with nearly half of the market between the two of them. We estimate that Trane has high-teens share and Lennox is in the mid-teens, followed by Rheem and then York and Nordyne.

Figure 314: Residential Unitary Market Share

2020 %



Source: Company reports and J.P. Morgan estimates.

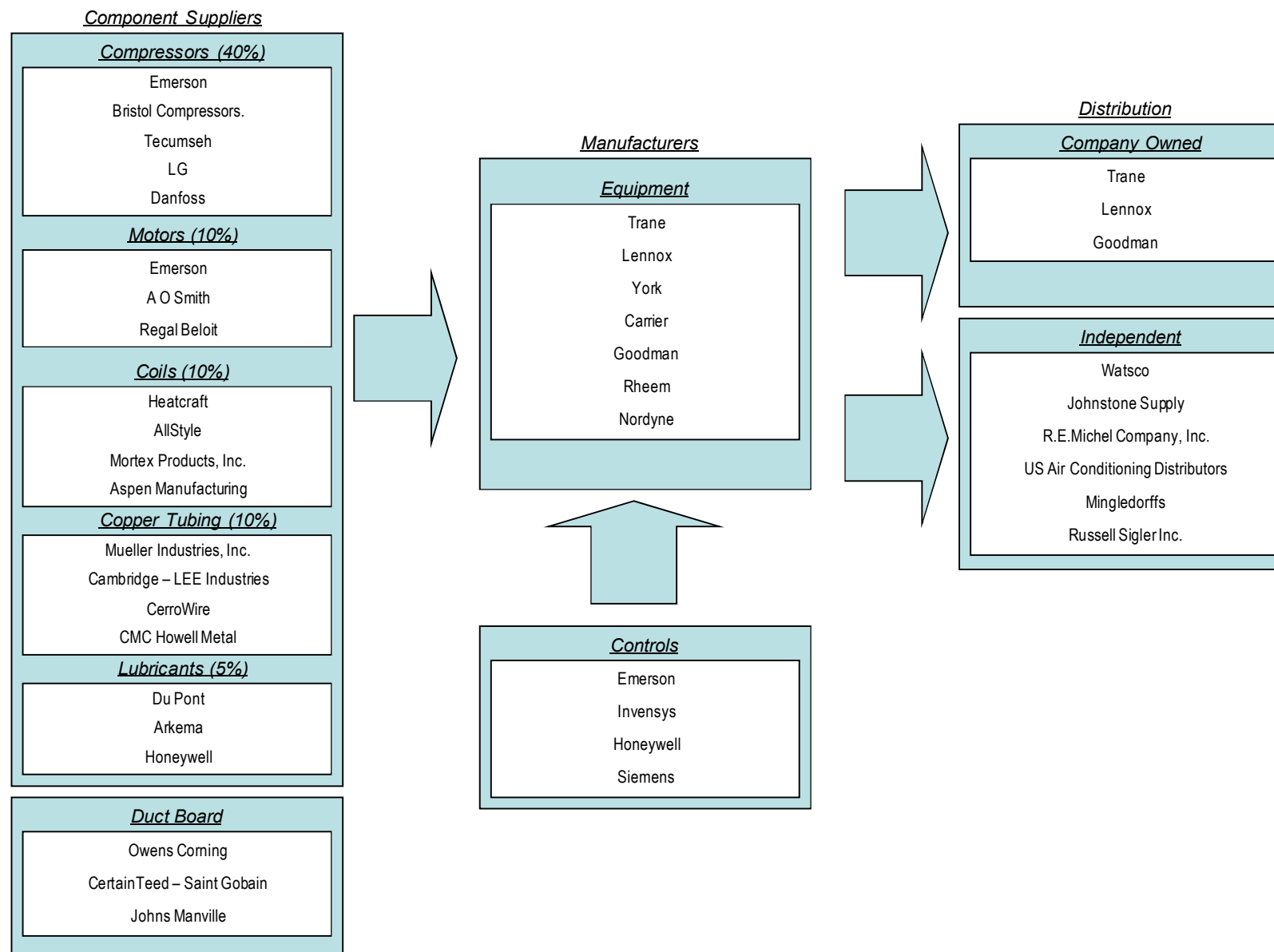
Component suppliers—Looking at sub-suppliers, the primary components within a residential unitary system are a compressor, a motor, coils, refrigerant, copper tubing, and other raw materials used to package the system (duct board for ventilation systems and steel, copper, and aluminum for packaging, etc.). Excluding duct board and control systems, we estimate that the system components cost ~75% of the total, with another 10% for steel/aluminum and the remaining 15% for labor/overhead costs.

- **Compressors (~40% of total cost):** A compressor is the most important and costly component of an HVAC system. It is used to convert a refrigerant from a gas to a liquid, which is then sent through the copper tubing inside the house into the evaporator coil. The largest manufacturer of compressors globally is Copeland, which is owned by Emerson Electric. Another manufacturer is Tecumseh. Recently, the compressor market has also seen increased competition from foreign manufacturers, such as LG (now used by LII as a secondary compressor supplier) and Danfoss, which we discuss a bit more in the Compressor section.
- **Motors (~10% of total cost):** Motors are used to run the blowers that circulate air through the system. The HVAC motor market is fairly consolidated, with the top suppliers being Regal Beloit (which also owns A.O. Smith, a former competitor) and Nidec (recently acquired Emerson's motor business).
- **Coils (~10% of total cost):** There are two coils in an HVAC system, an outdoor condenser coil and an indoor evaporator coil. The outdoor condenser coil is used to remove heat from the refrigerant gas, which then converts it into a cooler liquid that is transported through copper tubing to the indoor evaporator coil. The evaporator coil receives the liquid refrigerant, causing it to cool. Air is forced over the cool coil and delivered into the house's duct work. There are several manufacturers of coils that generally do not play in the compressor or motor space. They include Heatcraft (owned by Lennox), All Style, Mortex Products, and Aspen Manufacturing.
- **Copper Tubing (~10% of total cost):** As discussed above, the copper tubing in an HVAC system is used to pass refrigerant between the indoor and outdoor components of the system. Several companies supply copper tubing, including Mueller, Cambridge-Lee, CMC Howell Metal, and Cerrowire, to name a few.

- Refrigerants (~5% of total cost): Refrigerants are also a key component for an HVAC system as they provide the function of cooling the evaporator coils. As discussed in this report, government mandates have forced a change in the types of refrigerants. Historically there were a dozen or more suppliers of R-22 refrigerants, but with the switch to R-410a, there are now only a handful of manufacturers, which include Honeywell (leading share), Dupont, and Arkema.
- Duct Board (varies depending on house size): Duct board is used in the construction of ducted central A/C systems, which guide conditioned air throughout the house (and stale air back into the system). Manufacturers include Owens Corning, Johns Mansville, and Certainteed.
- Controls (few hundred dollars): Controls are essentially the thermostats, or the software used to manage the system. While many HVAC manufacturers are beginning to make their own controls, there are also outside suppliers that include Honeywell (the market leader), Google Nest, and Emerson.

The map on the next page provides some perspective as to how the different players fit into the resi unitary sales channel.

Figure 315: Residential Unitary HVAC Market Map



Source: J.P. Morgan

Other Equipment, Primarily Ductless (~15-20% Industry Sales)

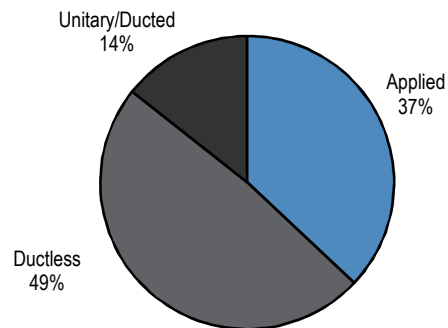
Other types of equipment include ductless equipment such as room/window air conditioners that are more like appliances. Our report focuses less on this segment of the industry as these markets tend to be dominated by non-US manufacturers selling outside the US. Ductless equipment is very popular in international markets such as Asia.

- Window or room air conditioning is ductless equipment and is a small, self-contained system that houses a coil and a compressor usually used for the cooling of a single room. This business is dominated by low-cost producers on a global basis, including LG Electronics, Fedders, Haier, Whirlpool, Electrolux, Matsushita (Panasonic, National), Mitsubishi Electric (Melco), Fujitsu, and Gree, with primary distribution through retail channels and distributors.
- Mini-splits are a more sophisticated segment of the ductless space and a key part of the world market (especially in Asia), which is dominated by foreign manufacturers such as Daikin, Mitsubishi, LG, Haier, and Sanyo. Internationally, mini-splits are most commonly used for applications in which US observers would be accustomed to seeing a ducted unitary product (i.e., single-family homes, light commercial).

Commercial Products & Manufacturers

There are two major product types of commercial equipment: larger applied systems and smaller unitary systems. We estimate that the total global commercial HVAC equipment market is ~\$40 B (~26% of total global HVAC sales), with the breakout being applied systems ~35%, ductless ~50%, and unitary ~15%.

Figure 316: Commercial HVAC Product Breakdown (~\$39 B)
2020



Source: J.P. Morgan estimates.

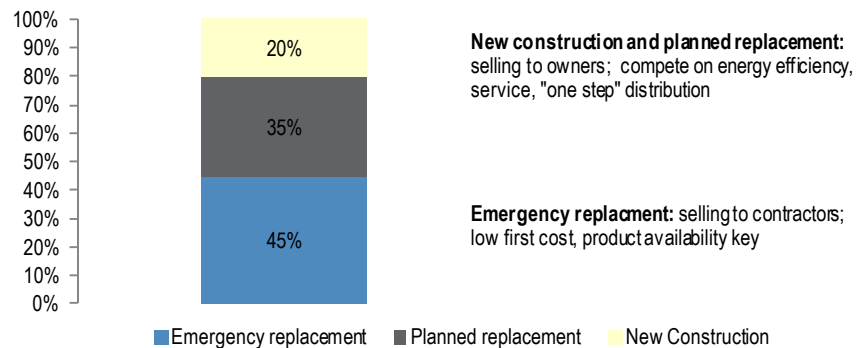
Before we jump into the various segments of the commercial equipment market, we provide a snapshot of how Trane (formerly Ingersoll-Rand) has historically classified the end-market segmentation. This represents its view of total commercial HVAC equipment, which includes both unitary and applied equipment.

Light Commercial/Commercial Unitary (~5% of industry revenues)

We estimate the U.S.-centric light commercial HVAC equipment market, or “commercial unitary,” at ~\$6 billion, or ~5% of industry revenues, with North America at ~\$5B. Commercial unitary equipment is essentially a large residential unit, consisting of a condensing unit (compressor and condenser) and an evaporator coil, with a price range estimated at \$1,500-30,000 and an average of ~\$5,500, according to Frost and Sullivan. The useful life ranges 12-15 years, and a typical lead time for a large rooftop unit is about 4-6 weeks, with lighter units shipped in 36-48 hours. More recently, Frost & Sullivan has estimated light commercial HVAC products to be designed for life expectancy of 15-20 years.

Demand drivers—Similar to the applied marketplace, this market is driven by new construction and replacement demand, which is the major driver for business in this segment, making up roughly 70-80% of volumes. The chart below shows Lennox’s estimate of the North American Unitary market, which it estimates at 80% replacement. Most segments of the commercial unitary market are value-driven, particularly the emergency replacement markets. Higher-efficiency units make up ~30% of the market, demonstrating that there are interested customers that will pay for performance. These are mostly big national accounts that are focused on life-cycle cost (LCC) and planned replacement cycles. Small developers that lease space tend to go for the lowest cost equipment. Unitary equipment is sold both directly to the customer by manufacturer representatives (common for national accounts) as well as through independent contractors (more common for emergency replacement).

Figure 317: Lennox View of North American Commercial Unitary Market



Source: Company reports, J.P. Morgan

In recent years, unitary equipment demand has been helped by the market's move toward smaller equipment due to lower upfront/operating costs, convenience, and greater flexibility. For instance, end users have the ability to install one or more smaller units as opposed to a larger applied system that could create overcapacity. In addition, customers who are unsure of capacity levels can more easily add/subtract smaller units with unitary systems. Other major benefits include unitary equipment's smaller size, easy maintenance, simple control, and efficient design.

End markets—Commercial unitary is best suited for use in small to medium-size commercial buildings, typically under three stories high. These structures represented the bulk of the commercial building stock during the 2000s cycle.

Figure 318: US Light Commercial End-Market Breakout

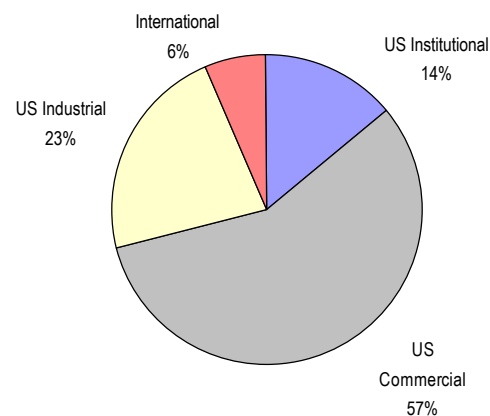
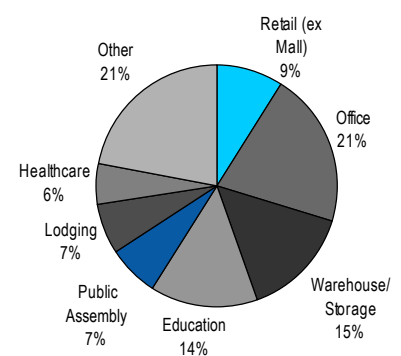


Figure 319: Commercial Unitary Applications by Floor Space, U.S. Non Commercial Building (2012)

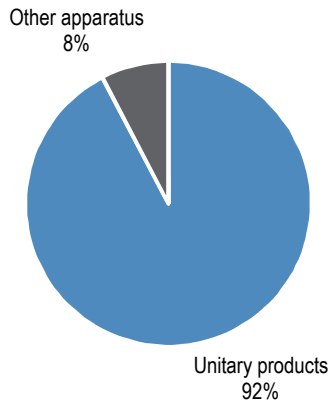


Source: EIA.

Source: Frost and Sullivan and J.P. Morgan estimates.

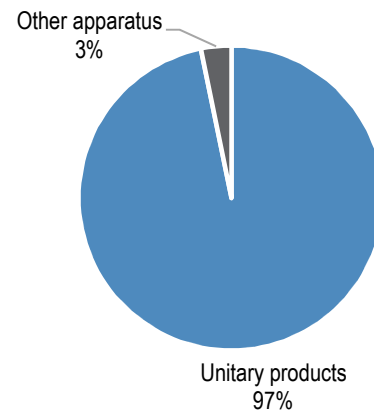
Note: Institutional includes hospitals, government buildings, schools, etc.; commercial includes offices, retail, and others; industrial includes manufacturing, warehousing, etc.

Figure 320: # Small to Middle Market Size Buildings (1,000-25,000 sq ft) Cooling Apparatus (2012)



Source: EIA.

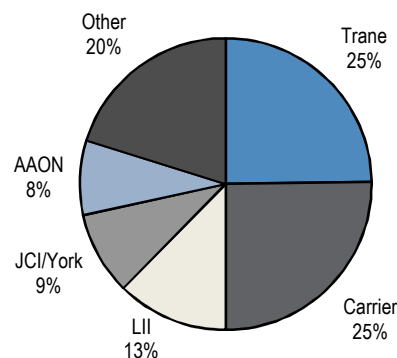
Figure 321: # Large Size Buildings (25,000->500,000 sq ft) Cooling Apparatus (2012)



Source: EIA.

Key players and market share—The top manufacturers in the commercial unitary equipment space include Carrier, Trane, and LII, which collectively make up an estimated ~65% of the industry, by our estimates. Frost and Sullivan estimates that there are probably 40-60 tier-two competitors, including AAON and York, with a big portion of this business going to higher-cost, custom applications. While estimates of share vary, we estimate that Carrier and Trane are the leaders in commercial unitary, followed by LII. Among the top players, LII has traditionally been more focused on direct sales to national accounts, while Carrier/Trane have had a more mixed model, which includes a bigger presence in emergency replacement, though Lennox has recently been making a strong push into the emergency replacement space. Among the second tier, AAON plays in a smaller sliver of the market that's more tailored to specific applications, where they compete more in higher tonnage, highly customized, more complex unitary rooftop equipment. Here they note seeing competition more from the likes of Daikin (McQuay) and Valent (Greenheck) than they do from any of the big four.

Figure 322: North America Light Commercial Market Share (~\$5B)



Source: J.P. Morgan estimates.

Large Commercial HVAC Equipment (~10% of industry revenues)

We estimate that the large commercial HVAC equipment market is ~\$15B, or ~10% of industry revenues. This represents all chillers sold as well as the related applied equipment such as air handler and fan coils. According to Frost and Sullivan, these systems come in a price range of \$30,000-250,000, with an average cost of ~\$100,000. Commercial applied equipment is built to order and consists of components such as a chiller, condenser, evaporator, and compressor, along with controls and motors for a multi-zone cooling application. The useful life of applied equipment and chillers is 20-30 years and a typical lead time for a large chiller is 8-12 weeks.

Equipment landscape—While this market segment is often referred to generically as “chillers” (the key cooling unit that is provided by the major OEMs like Trane/Carrier), keep in mind this is only one of the components of a large cooling system. The table below provides examples of the major products that go into an applied system, many of which are provided by the HVAC OEMs but some (i.e., cooling towers, pumps) that are not.

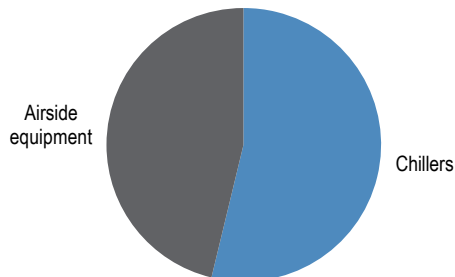
Table 115: Common Applied Equipment Products and Competitors

Product	Major Companies	Market Size
Air Handling Units	Trane York Carrier McQuay Dunham Bush	~2,000
Central System Terminal Boxes	Titus Trane ETI	~375
Fan Coil Units	IEC Trane McQuay	~250
Classroom Unit Ventilation	Trane McQuay	~325
Cooling Towers	Baltimore Air Coil Marley Evapco	~1,100
Pumps	Taco Bell & Gosset Paco	~650

Source: DOE estimates

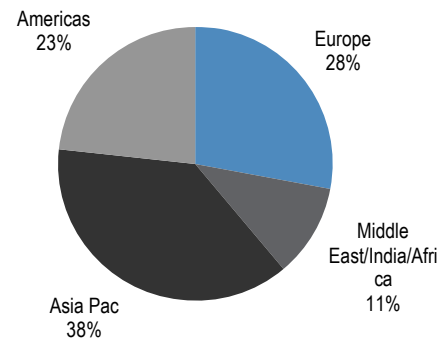
BSRIA estimates the global applied market as being about 54%/46% chillers/airside equipment. Geographically, Asia is the biggest region, followed by Europe/Americas, and MEA.

Figure 323: Global Chiller and Airside Equipment Markets
%, \$ value



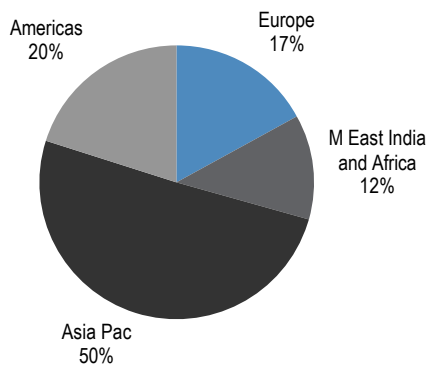
Source: BSRIA

Figure 324: Global Chiller and Airside Equipment Markets by Region
%, \$ value



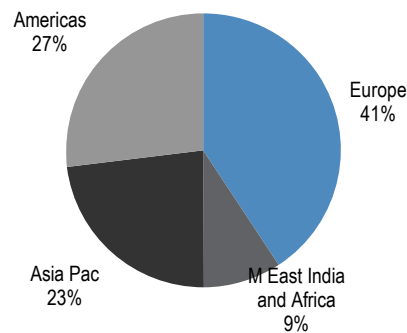
Source: BSRIA

Figure 325: Global Chiller Equipment Market By Region
%, \$ value



Source: BSRIA

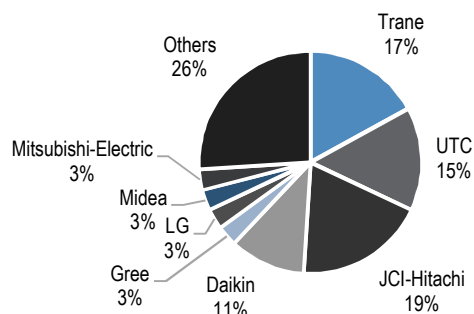
Figure 326: Airside Equipment Market by Region
%, \$ value



Source: BSRIA

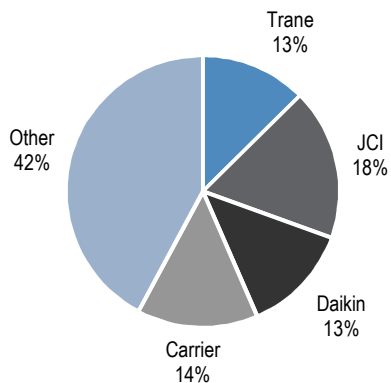
From a market share perspective, JCI gave us their best estimates of market breakouts by type of equipment. Note that these are global breakouts, therefore may differ optically from other market share numbers companies give, as the North America market appears to be more concentrated than globally, where Trane for example would stand closer to ~30-40% market share in chiller equipment vs the share shown below. Diving into these breakouts, the top 4 players share 55-60% of the chiller market evenly, with JCI slightly ahead. Midea also gave its view of the global chiller market with data from BSRIA, as shown below (note this is 2017 data, but we believe this breakout should not have changed by much). By type of equipment, these players share 75% of the ~\$1.9B air cooled market, with Carrier ahead, as well as 75% of the ~\$1.9B centrifugal market, with JCI at 2x the market share of the other three. On water cooled equipment, this ~\$1.3B market looks more fragmented with JCI behind the other three at mid to high teens share. Lastly, in the \$1.5B mini chillers market, the four players share 40% of the market evenly, with Trane slightly behind. Below, we look at these market share dynamics and summarize the major chiller products for JCI/Trane/Carrier in various segments of the large commercial market.

Figure 327: Global Chillers Market Share (2017)



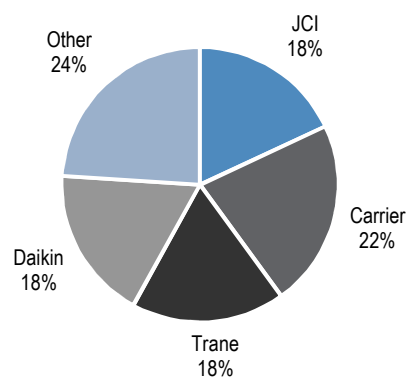
Source: Midea

Figure 328: Global Chillers Market Share %



Source: Johnson Controls estimates.

Figure 329: Air Cooled Equipment Market Share (all tonnage, scroll and screw) %



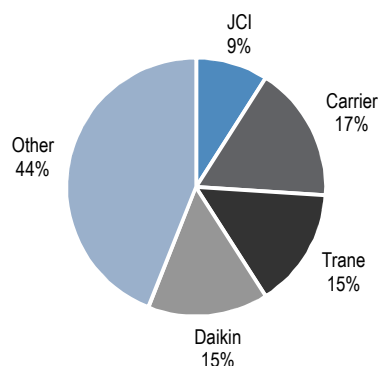
Source: Johnson Controls estimates.

Table 116: Major Air Cooled Chiller Offerings by Company

Product	Description	Compressor	Capacity (tons)	Notes
JCI York				
YCAL	Air cooled scroll chiller	Scroll	50 - 225	Self-contained unit designed for easy, low cost outdoor installation
YVFA	Free cooling VSD screw air cooled chiller	Screw	115 - 380	Low operating cost, variable speed drive compressor
YVAA	Air cooled variable speed drive screw chiller	Screw	150 - 500	Lowers energy consumption and reduces noise levels
YCIV/YCAV	Air cooled variable speed drive screw chiller	Screw	150 - 515	High efficiency and quiet operation at low first cost
CYK	Compound centrifugal chiller	Centrifugal	300 - 2500	Designed for high-head conditions to handle applications with unique differential pressure
Carrier				
AquaSnap® 30RAP	Air cooled liquid chiller with puron refrigerant	Scroll	10 - 150 Std,	All-in-one package that is easy to own and cheaper than others in class
AquaSnap® 30RB	Air cooled liquid chiller with puron refrigerant	Scroll	60 - 390 Std,	All-in-one package that is easy to own and cheaper than others in class
AquaForce® 30XA	Air cooled liquid chiller with R-134a refrigerant	Screw	80 - 500 Std,	Premium air-cooled chiller packages for contractors, consulting engineers, and building owners
AquaForce® 30XV	Air cooled liquid chiller with R-134a refrigerant	Screw	140 - 500	Can be customized to fit any building need; made for versatility and robustness
AquaForce® 30KAV	Air cooled liquid chiller with 134a and 1234ze (EU only) refrigerant	Screw	140 – 370	High efficiency and performance in a compact footprint
Trane				
CGAM	Air Cooled Scroll Chiller	Scroll	20-130	High efficiency, low sound levels and compact size, good for industrial or ice rink applications
Series RTAC	Air cooled screw chiller	Screw	120-500	Hermetic rotary refrigeration for comfort or industrial water cooling systems
Stealth RTAE	Air cooled Screw Chiller with Adaptive Frequency Drive	Screw	150-300	Part-load and full-load efficiencies with multiple sound reduction options
Sintesis RTAF	Air cooled Screw Chiller with Adaptive Frequency Drive	Screw	115-500	High part-load efficiency, multiple sound reduction options, uses LGWP refrigerants
Daikin				
Trailblazer®	Air cooled scroll chiller	Scroll	10-240	High efficiency and quiet operation. When power interrupted, RapidRestore® and Fast Loading make it ideal for data centers, healthcare facilities
Pathfinder®	Air Cooled Screw Chiller	Screw	100-565	High energy efficiency and low noise within a compact footprint

Source: Company reports

Figure 330: Water Cooled Market Share



Source: J.P. Morgan estimates

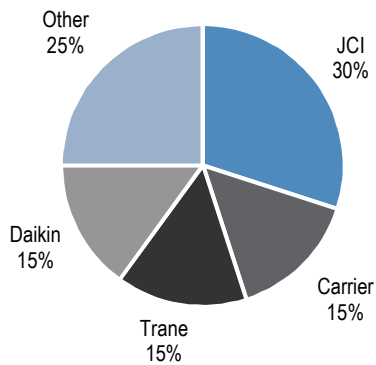
Table 117: Major Water Cooled Chiller Offerings by Company

Product	Description	Compressor	Capacity (tons)	Notes
JCI York				
YCWL	Water cooled scroll chiller	Scroll	50 - 200	Wide range of comml and industrial applications, compact with low op costs
YVWA	Water cooled variable speed screw chiller	Screw	125 - 300	Flexible configurations, reduces compressor speed to increase energy savings
YIA	Water cooled single stage absorption chiller	Absorption	120 - 1,380	Rugged industrial design ideal for applications where waste energy is produced
YZ	Water-cooled Magnetic bearing centrifugal chiller	Centrifugal	165 - 1,350	New flagship chiller, fully optimized with around the new ultra-low GWP refrigerant 1233zd and lower COO.
YMC2	Centrifugal magnetic drive chiller	Centrifugal	165 - 1,000	Features active magnetic bearing technology and reduces noise
YK	Centrifugal chiller	Centrifugal	250 - 3,000	Low COO, variable speed drive, made for schools, hospitals, high rises, DCs
CYK	Compound centrifugal chiller	Centrifugal	300 - 2500	Designed for high-head conditions to handle unique differential pressure
YST	Steam turbine centrifugal chiller	Centrifugal	700 - 2,800	Designed for large combined heating and power (CHP) plants
YD	Dual centrifugal chiller	Centrifugal	1,500 - 6,000	Compact config, variable speed drive, made for industrial or process installs
YK-EP	Centrifugal chiller w/ economizer	Centrifugal	2,500 - 3,500	Provides additional capacity through economized cycle
OM	Custom design centrifugal chiller	Centrifugal	3,000 - 5,500	For large scale cooling projects, double size of the largest packaged chiller
Carrier				
AquaSnap 30MP	Condenserless chiller	Scroll	16 - 71	Packaged liquid and condenserless chiller with compact design
16LJ	Low temp absorption chiller	Absorption	75 - 525	Large capacity comfort cooling apps like office buildings, hospitals, universities
AquaForce® 30HX	High efficiency indoor liquid screw chiller	Screw	75 - 265	High efficiency, indoor water-cooled or condenserless chillers. Compact with low vibration design.
AquaForce® 30XW	Liquid chiller with R-134a	Screw	150 - 400	Good part load efficiency and compact design, for replacement units
AquaEdge® 23XRV	Variable speed screw chiller	Screw	175 - 550	Modern, efficient chilled water plants
AquaEdge 30XWV	Water cooled liquid chiller with 134a and 1234ze (EU only) refrigerant	Screw	170-465	Good performance and value with a low GWP option
16TJ	Single effect steam fired absorption chiller	Absorption	100 - 700	Large capacity comfort cooling applications like office buildings, hospitals, universities, as well as mfg facilities and light industrial process cooling
16NK	Double effect steam fired absorption chiller	Absorption	98 - 1323	Large capacity comfort cooling applications like office buildings, hospitals, universities
AquaEdge® 19XR	High efficiency, semi-hermetic centrifugal chiller	Centrifugal	200 - 3000	Specifically for chlorine-free refrigerant
AquaEdge 19XRV	Water cooled liquid chiller with 134a and 513a refrigerant	Centrifugal	200-3500	Superior efficiencies at true operating conditions, without compromising the environment
AquaEdge® 17DA	Water cooled, custom designed centrifugal chiller	Centrifugal	3000-5500	Large tonnage applications where performance and energy efficiency vital
AquaEdge® 19DV	Water cooled liquid chiller with 1233zd refrigerant	Centrifugal	400-1000	Features ceramic bearings, a 2 stage compressor and a color touchscreen display. Better efficiency and free cooling capability at low loads.
Trane				
CenTraVac series	Water-Cooled Liquid Chiller	Centrifugal	120-4000+	Main chiller line. 9 different products across various capacity ranges.
Cold Generator series	Water-cooled Scroll chiller	Scroll	20-70	Family of 6 compact scroll chillers with applications including Education, Healthcare, Municipal, Commercial, Light Industrial
Agility series	Water-cooled Centrifugal chiller	Centrifugal		Maximize building performance with compact solution to reduce install complexity
Series R Helical Rotary Chillers	Water-cooled Rotary chiller	Rotary	80-250	Industrial-grade design for both industrial and commercial use. Includes RTWD and RTUD models.
Helical RTHD	Water-cooled Rotary chiller	Rotary	125-450	Industrial-grade design for both industrial and commercial use
Daikin				
Magnitude® Magnetic Bearing	Water-cooled Centrifugal chiller	Centrifugal	86-1600	The most comprehensive size range of oil-free magnetic bearing chillers
WSC Centrifugal	Water-cooled Centrifugal chiller	Centrifugal	300-1800	Single compressor centrifugal chillers using HFC-134a refrigerant, with smallest footprint per ton in the industry
WDC Centrifugal	Water-cooled Centrifugal chiller	Centrifugal	600-2700	Dual compressor centrifugal chillers take up less floor space than multiple single compressor chillers, while delivering the combined capacity
Navigator®	Water-cooled Screw chiller	Screw	120-300	Engineered as a fully VFD-driven platform to meet building applications that aren't suited for traditional chillers
WGZ Scroll	Water-cooled Scroll chiller	Scroll	30-200	Shipped complete, designed for easy retrofit, among quietest and most reliable chillers available

Source: Company reports

Figure 331: Centrifugal Market Share

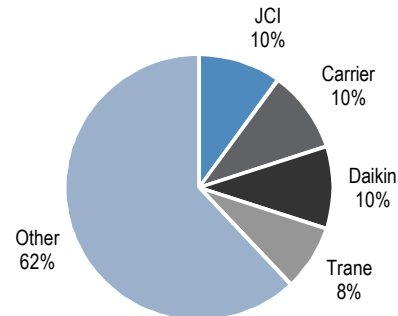
%



Source: Johnson Controls estimates.

Figure 332: Mini Chillers Market Share

%

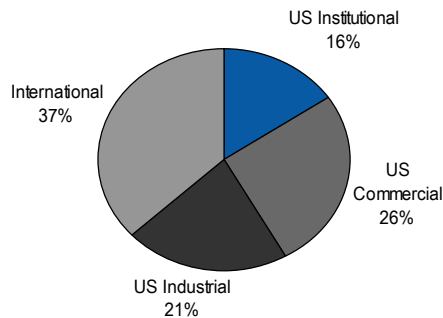


Source: Johnson Controls estimates.

Demand drivers—This market is driven by a combination of new construction and replacement sales. The bulk of the replacement and retrofit market is domestic, where the installed base is largest. On the replacement side, sales are driven by the age of the equipment (life cycle is usually 20-25 years), the attractiveness of economics for repair versus replacement, and the likelihood of increased energy efficiency and greater environmental acceptability. While the phase-out of older chillers utilizing harmful CFCs is ongoing, and represented a nice catalyst in the late 1990s, growth in this segment has been slower than expected, and we do not view this variable as a key catalyst to growth near term.

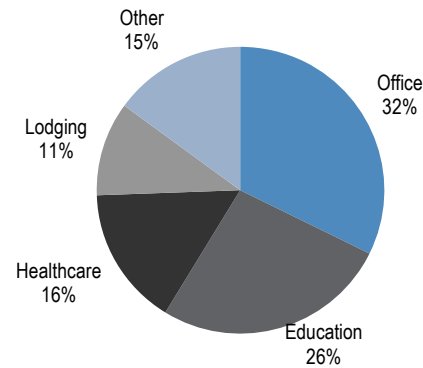
End-market focus—The charts below provide some estimates of the end-market profile. Keep in mind that, relative to commercial unitary products, applied systems are going to be used more often in applications that require large sophisticated cooling schemes such as industrial, large office, lodging/hotels, educational (universities), and institutional (hospitals). They are less common in retail or small office buildings.

Figure 333: Large Commercial/Applied End-Market Breakout
%



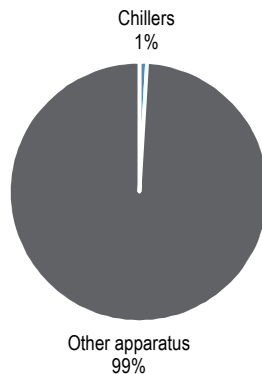
Source: Frost and Sullivan and J.P. Morgan estimates

Figure 334: Chiller Applications by Floor Space, U.S. Commercial Building
%



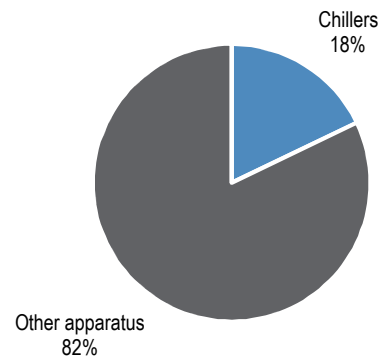
Source: Energy Information Administration (EIA).

Figure 335: # Small to Middle Market Size Buildings (1,000-25,000 sq ft) (2012)



Source: EIA.

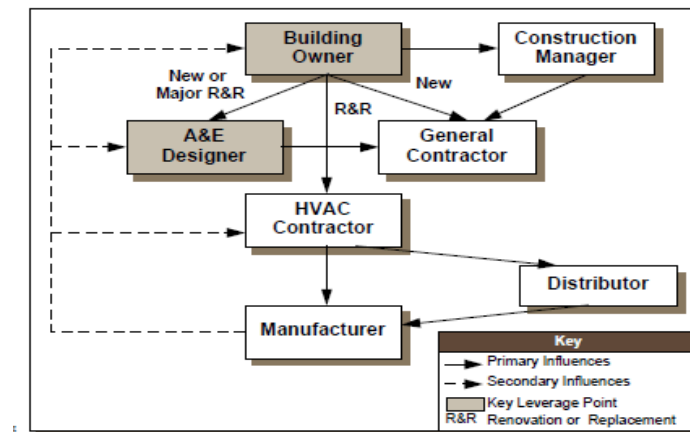
Figure 336: # Large Size Buildings (25,000->500,000 sq ft) (2012)



Source: EIA.

Sales process—Most of the large equipment business is done through planned specification with some design and build as the building owner hires an agent or design engineer to make the product choice. Price remains a key factor in the customer's buying decision, though a strong service and warranty proposition, as the unit will be in place for a significant period of time, also represents a factor as post-installment service contracts are a growing focus for the OEM. However, this is not a commoditized product as the decision is often based not only on machine size and cost (both initial and through the life cycle) but also on performance, application, ambient conditions, and reliability/durability expectations. Most manufacturers have also now shifted toward a selling a solution, looking to differentiate through sales of systems that include the HVAC apparatus as well as controls. Sales of larger equipment tend to be direct to the end user through a dedicated sales force, though some smaller units are sold through independent contractors to the mechanical contractor, the ultimate buyer in a planned specification job.

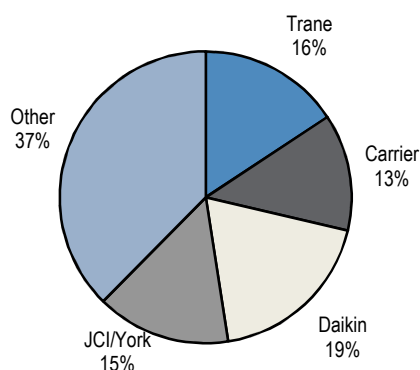
Figure 337: Commercial HVAC Buying Decision Tree



Source: DOE

Competitive landscape—The key manufacturers in the larger commercial equipment space include Carrier, Trane, York, and McQuay, which collectively make up an estimated ~60-65% of the industry. The top three companies own the majority of the share in the most sophisticated chiller applications, given a more engineered product that provides somewhat of a barrier to entry. The middle to lower end of the market, however, is more fragmented, particularly in regions like Asia. The commercial services market is much more fragmented, though still competitive, as the three major players, Carrier, Trane, and York, all fight for positioning to serve the large installed base and drive incremental volumes.

Figure 338: Global Large Commercial Market Share (~\$15B)
2020



Source: J.P. Morgan estimates.

Primer III: Components & Suppliers

As discussed above, the largest component in an HVAC system is the compressor, which we talk about in more detail below. We also talk a bit about motors and refrigerants, based on our review of publicly available information.

Compressors

Compressors are mechanical pumps driven by electric motors and are responsible for circulating and increasing the pressure of refrigerant. Prior to being acquired by Johnson Controls, York estimated the compressor market as a \$7B opportunity. Given the relative stability of compressor demand in recent years, we think this estimate remains reasonable.

Types of Compressors and Applications

The compressor is the largest single cost per unit at ~40% of the total unit, representing a smaller portion of larger machines. The different types of compressors, which we also detail below, are rotary, reciprocating, screw, centrifugal, and scroll. All types of compressors are either hermetic or not (completely sealed). Small hermetic compressors represent the majority of unit volumes (almost 80%), applications for which range from automobile air conditioners to household refrigerators to water coolers.

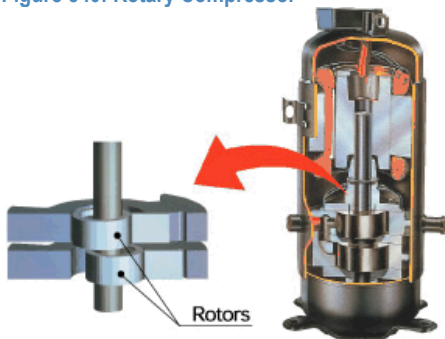
Figure 339: Scroll Compressor



Source: AC Quest.

Scroll—Unitary AC, Commercial Refrigeration: Scroll compressors are a sophisticated, high-end product with higher efficiency and quieter than other compressor technologies. They are sold in capacities of 1HP-60HP and can be used in a broad range of applications but primarily in unitary air conditioners, refrigeration, and more recently in VRFs (detailed discussion below). Copeland (Emerson) currently dominates the scroll compressor market for unitary applications with ~50% of the market share globally. Other vendors that compete in this space primarily are Daikin, Mitsubishi, Hitachi, Danfoss, and Bitzer. In the US, Copeland has largely maintained a monopoly historically, but in the last 10 years European vendors Danfoss and Bitzer have built capacity and taken away some share. According to JARN, the global scroll compressor market stands at ~15m units with the US (~8.3mm units) and China (~3.2mm units) the major markets followed by Europe, Japan, India, and other regions. In the US, scroll compressors are primarily used in unitary AC with almost full penetration, while in China applications pertain primarily to refrigeration products. Scroll compressor demand for refrigeration is growing, led by urbanization and the food industry in China. Global scroll compressor demand was up 1.7% in 2019, vs. ~1% growth in 2018, 6% in 2017, and HSD growth in 2016. The US grew ~5% and Europe was also up about 5% ex-Turkey and Russia, while China was down ~8%, and SE Asia increased on favorable demand for packaged A/C units.

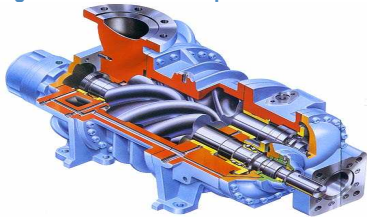
Figure 340: Rotary Compressor



Source: Sanyo, used with permission

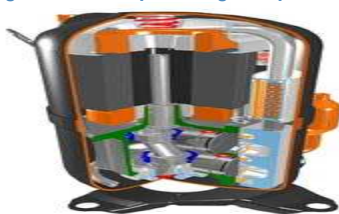
Rotary—Unitary AC, Small Chillers: Much like scroll compressors, rotary compressors provide increased operating efficiency, lower equipment space requirements, and reduced sound levels. However, they are relatively less sophisticated than scroll and are more of a commodity-like product, particularly in Asia (China). Most products sold are in the 1-3HP range, and primary applications in HVAC include unitary ACs with expansion into small chillers recently. Regionally, rotary compressors are dominant in China, which also includes applications outside HVAC, including heat pump clothes dryers, hot water heaters, etc. Rotary compressors are being adopted not just in RACs but in medium and large capacity packaged air conditioners and refrigeration applications as well. Asian manufacturers, particularly Daikin, are also adding inverter technologies to their rotary compressor products in order to make their products attractive and are also targeting the US market, where scroll compressors have a dominant share in unitary AC applications. Global rotary compressor demand was down 5% in 2019 to 174.9mm units (vs. up 4% in 2018, up 9% in 2017, up 11% in 2016), according to JARN, of which China accounted for 75% of the total.

Figure 341: Screw Compressor



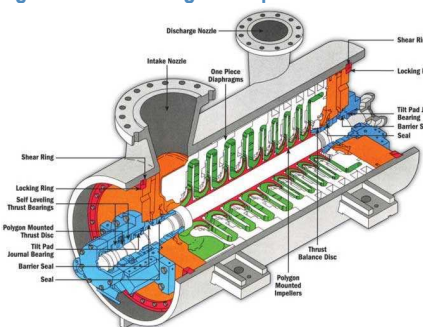
Source: Mycom

Figure 342: Reciprocating Compressor



Source: Bristol

Figure 343: Centrifugal Compressor



Source: Pneumotech

Screw—Chiller, Commercial & Industrial Refrigeration: The main application of screw compressors are chiller systems, including air-source, water-source, heat recovery, and ice storage. Due to integration of inverter technologies, screw compressors are increasingly replacing reciprocating and centrifugal compressors (see below) in chillers as they are able to deliver higher energy savings. Compared with reciprocating, screw compressors also require less maintenance and generally have lower overall operating costs. Regionally, China is the biggest market followed by the US and Europe. Global screw compressor demand was stagnant in 2019 (up LSD in 2016 and 2017, and “stagnant” in 2018), according to JARN.

Reciprocating—Unitary AC, Domestic and Commercial Refrigeration, Chillers: Reciprocating (or piston) compressors are broadly applicable and may include twin-single piston technology, allowing a single compressor to function in both heating and cooling modes. More often, however, pistons are added to increase compression capacity. Reciprocating compressors today are most often associated with refrigeration and process cooling, rather than HVAC, with the exception of small residential systems. Total demand in 2019 was 530K units for semi-hermetic reciprocating compressors (up 4%), and 19.8mm units for hermetic reciprocating compressors for light commercial (up 5%), according to JARN.

Centrifugal—Chiller, Commercial Refrigeration: These compressors are primarily used in chillers in excess of 280KW. Regionally, China and the US are the biggest markets, both in terms of sales and production, followed by South Korea, Japan, Southeast Asia and the Middle East. A few OEMs procure stand-alone products from Asian manufacturers, while others also produce their own centrifugal compressor (e.g., Lennox). Development of inverter-driven centrifugal compressors is increasing, while oil-free bearing compressor demand is rising substantially in the U.S. According to JARN, demand for centrifugal compressors increased 3% in 2019 (+2.6% in 2018, +3.5% in 2017) to 18,500 units, driven by growth in China, the U.S. and South Korea; while the Middle East market declined y/y. The use of magnetic-bearing technology is becoming more prevalent in the centrifugal chiller industry and is beginning to replace traditional centrifugal chillers and some screw compressors (particularly water-cooled screw chillers in ACs) due to increased energy efficiency, reduced noise and easy maintenance. JARN estimates that magnetic-bearing centrifugal chillers are growing at ~8% on average globally. On a volume basis, the market is led by Australia (~80% share of the market), Europe (~50%), the U.S. (~40%), and China (~25%). According to Haier, magnetic-bearing high-efficiency

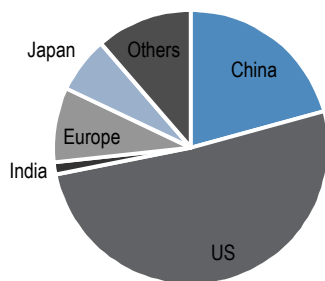
centrifugal chillers for data centers will have bright market prospects in the future, driven by green and high efficiency HVAC&R policies, continuous development of high-efficiency data centers, and new brand entrants into the market driving continued improvement in technology.

Scroll Compressor Market Dominant in North America

Compressors are one of the few areas within HVAC that present an opportunity for technology differentiation, mostly related to noise and efficiency, which is being driven by more electronics and different degrees of variable speed compressors, mostly in scroll.

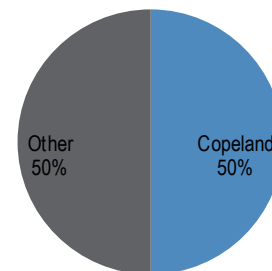
Overall Market: JARN estimated the total world scroll compressor market in 2019 to be ~15 mm units, up ~1.7% y/y. Copeland (Emerson) dominates the world market with ~50% share. Other vendors that compete in this space are Daikin, Mitsubishi, Hitachi, Danfoss, and Bitzer. Some rotary compressor manufacturers like GMCC and Shanghai Hitachi are starting to produce scroll compressors, while LG has been increasing its production capacity.

Figure 344: Scroll Compressor Market Unit Split



Source: J.P. Morgan

Figure 345: Scroll Compressor Market Share (Worldwide)



Source: J.P. Morgan estimates

Regional/Competitive Landscape: The U.S. and China are the two largest markets as well as the largest producers of scroll compressors. In 2019, the U.S. market grew ~5%, while China decreased ~8% (primarily due to the economic impact from trade/tariffs). Applications for scroll compressors tend to vary according to region. In the U.S. they are primarily used in air conditioners and rooftop units. In Asia they are used mostly in PACs, VRFs and chillers, and Japan and China, in particular utilize them in heat pump chillers. In Europe, they are mainly used in refrigeration. Copeland dominates the U.S., but Asian manufacturers continue to make their moves there, including Daikin's most recent purchase of Goodman. This has also opened up the market for inverter scroll compressors in the region that is more predominant and has higher penetration in Asian regions, particularly in China. In China, the overall scroll compressor market is a little more fragmented with a number of local and Japanese players having manufacturing presence in the region. Dalian Sanyo (Panasonic) and Hitachi have the leading share in the region. In Japan, Hitachi holds the top share followed by Mitsubishi Electric.

Table 118: Scroll Compressor OEM Factory Presence (2018)

Manufacturer	US	China	Japan	Thailand	Others
Copeland	X	X		X	X
Danfoss	X	X			X
Bitzer	X	X			X
Hitachi		X	X		X
Daikin		X	X	X	X
Panasonic	X	X	X		X
Mitsubishi Electric	X	X	X	X	X
Dalian Sanyo (Panasonic)			X	X	
Toshiba Carrier			X		
MHI		X	X		X
LG	X	X		X	X
Samsung	X	X		X	X

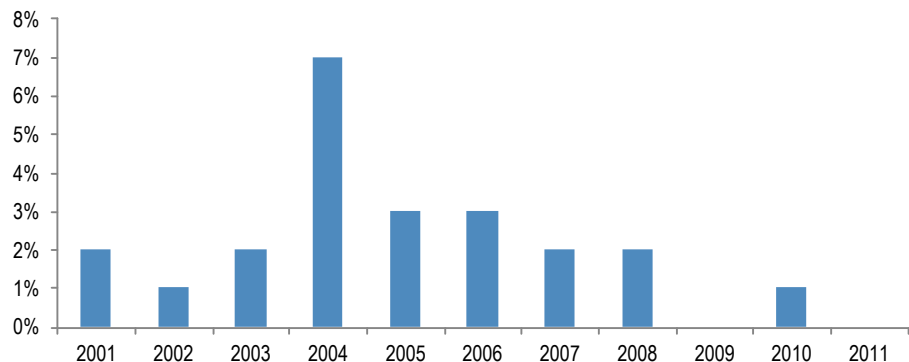
Source: JARN

Refrigeration Market: As per Copeland's commentary, refrigeration is growing fast and now accounts for about a third of demand. Copeland is also the key global leader in this market. Other manufacturers include Panasonic (Dalian Sanyo), Danfoss, JCI-Hitachi and Invotech. Additionally, as per Copeland's commentary, larger scrolls are beginning to penetrate sizes previously dominated by screw technology, bolstered by the successful introduction of 40-hp scroll compressors by Copeland and Danfoss. Panasonic has also followed and is having some success.

Scroll penetration grew rapidly last cycle: The product proliferated during the last cycle, and following the 13-SEER transition, market penetration of scroll is estimated to have moved (2003-08) from ~50% to ~85% in U.S. HVAC applications. This was evident by data from Emerson's (Copeland) 10Ks, in which management pointed to average 2% annual revenue growth (7% in 2004 alone) from penetration gains over the course of the last cycle. The technology here was so strong that Bristol Compressors, the other main supplier, was sold in 2007 as part of the JCI/YRK deal for \$350 mm, or ~0.5x sales.

Figure 346: Scroll Penetration Was a Key Driver of EMR Climate Growth Last Cycle

% sales growth from penetration gains (per 10-Ks)

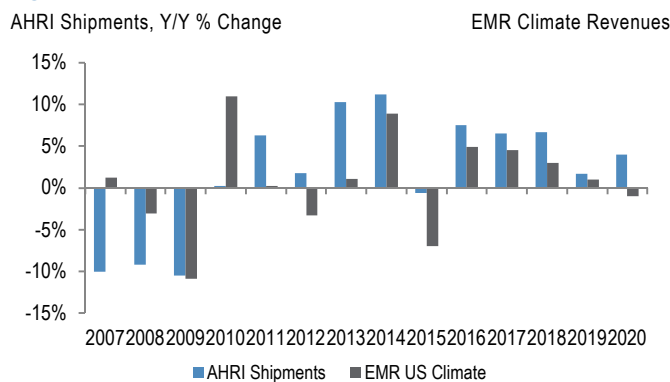


Source: Company reports and J.P. Morgan estimates.

Demand Drivers for Compressors

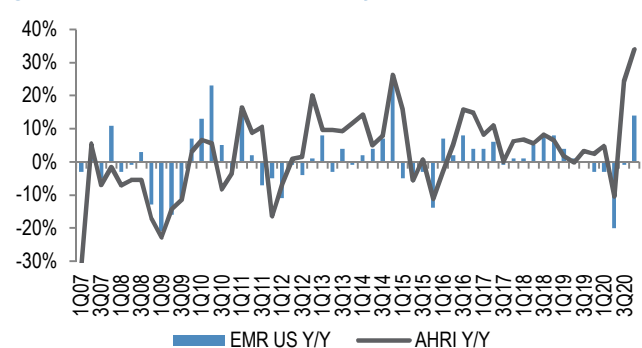
The figures below show that trends in volume shipments of compressors have historically tracked those in unitary products (each OEM shipment has one compressor). The key difference is that compressors can also be sold as replacement parts through the distribution channel for unit repairs, something that increased through the economic downturn and still exists today. Therefore, we estimate that the market is slightly more slanted toward replacement than the OEM market (i.e., approximately 90% versus 85%). Keep in mind that repair compressors also come in at a slightly higher margin, given their one-off sale through distribution rather than to a large, sophisticated OEM customer.

Figure 347: EMR Climate Sales Decoupled from AHRI Shipments



Source: Company reports, AHRI

Figure 348: EMR US Climate vs. Industry AHRI Shipments



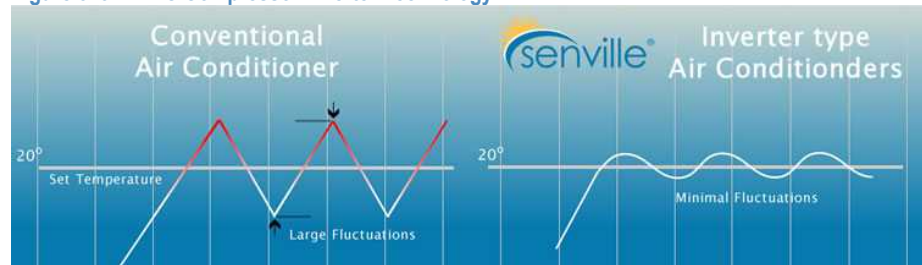
Source: Company reports, AHRI

Inverter Technology—Bringing Cruise Control to Compressors

One key dynamic punctuated by Daikin's purchase of Goodman is the emergence of inverter technology. Inverter technology is the use of an electrical inverter to smooth out variability in compressor run rates around the set point. The variable frequency drive uses a rectifier to convert the incoming alternating current to direct current and then uses the inverter to produce AC at the desired frequency. A microcontroller then regulates and adjusts based on temperature changes; these electronics add to the cost of the equipment, with conversion driving some energy losses. Smoothing out fluctuations makes the AC less prone to breakdowns, cheaper to run, and quieter.

A good analogy would be the cruise control function of an automobile. Imagine a car being driven on the highway at 50 miles an hour, and an accelerator press takes it to 100m/hour, and then it goes back to 50 and then 100 and repeats. This results in a lot of fuel wastage. However, once the car is taken to 75m/h and the cruise control is switched on, the engine smoothly increases or decreases its speed to maintain the 75m/h speed and the resulting fuel usage is much lower.

Figure 349: HVAC Compressor Inverter Technology



Source: Senville. (used with permission)

Technology pioneered by Asian players, but penetration slow: Inverter controllers were first taken up in rotary compressors and then spread to scroll compressors once mass production brought down costs. Nevertheless, inverter compressors still have higher costs than non-inverter compressors, so the profit recovery rate from lower operating costs will be the key to inverter penetration in the market, and manufacturers need to be able to design costs out of the rest of the system to make it a mass-market product. The technology and product is currently dominated by Asian players like Daikin and LG that are leveraging their scale and proprietary technology to bring it to a lower cost, but US OEMs are developing their own technologies that are showing up in higher efficiency units.

Most leading air conditioner manufacturers currently use the inverter scroll technology and are increasing production of this product with rising demand for VRF applications. From a competitive standpoint, the emergence of the inverter compressor had caused talk around the industry of the risk of vertical integration by Daikin and others, a potential negative for incumbents like Copeland. However, progress on this front by OEMs has been undoubtedly slower than initially hyped, and Copeland has positioned itself well with new technologies at the middle range of the market with modulating compressors for 15-18 SEER products. True inverter technologies remain targeted at the ultra high end (18+ SEER), and traditional scroll continues to dominate the lower end (14-15 SEER). The key TBD over the next few years will be the ability for inverter technology to penetrate more mainstream products below the 18 SEER level. Daikin would be the key player to watch here, but the company is using Copeland's next generation two stage compressor in Goodman's 16-18 SEER systems. In our view, this demonstrates that the talk over the past couple of years about inverter penetration has been a bit more hype than reality, further underscored by commentary from players such as Lennox who have said they are not as focused on bringing variable speed technology to lower end products. With the overall HVAC market continuing to be stable in most aspects, evolving strategic decisions around compressor initiatives/technology will stand out as key competitive differentiators among OEMs and incumbent compressor suppliers, but we think EMR remains well positioned as the dominant player that is evolving successfully as technology steadily improves.

Refrigerants

Types of Refrigerants currently used in the HVAC industry

A few different types of refrigerants are being used in the HVAC industry currently that vary by region and regulatory constraints in those regions. These include R-22, R410A, R32, Solstice L-41, R407C, and R123 (centrifugal chillers). Basic characteristics differentiating these refrigerants are global warming potential (GWP), flammability, discharge temperature, and overall system efficiency. The most common refrigerants used worldwide currently are R-22 and R410A with R32 and L 41 steadily gaining popularity as alternatives to R410A, and new mildly flammable and non-flammable refrigerants are coming to the fore as longer-term solutions to the coming regulations, including the R-454B and R-466A.

R-22: R-22 (hydrochlorofluorocarbons, HCFC-22) has been the most widely used refrigerant but is being phased out in developed countries due to its ozone-depletion potential along with high global warming potential. This refrigerant is now increasingly being replaced worldwide as per the Montreal Protocol by HFC (hydrofluorocarbon) refrigerant, which has less ozone-depletion potential due to the absence of chlorine) and other refrigerant blends. The refrigerant is widely available and produced by a highly fragmented market.

R-407C: This refrigerant has been used as an alternative to R-22 and can be used in existing R-22 (unlike the R-410A) air-conditioning systems. However, manufacturers suggest that changing from R-22 to an alternate refrigerant can generally compromise overall system performance.

R410A: This has been the most commonly used alternative to R-22 refrigerant, primarily due to its lower ozone-depletion potential. Only a handful of manufacturers produce this refrigerant, including Honeywell (leading share), Chemours, and Arkema.

R32: Marketed as an alternative to the R-410A due to its low global warming potential compared with R-410A, many regions and manufacturers are contemplating a shift to R-32, particularly in regions where R-22 hasn't been phased out aggressively, though this is only a medium-term solution as R-32 is not approved in resi central AC, mini-splits and multi-splits under the EPA SNAP program's 2015 Final rule.

Solstice L-41: A proprietary product by Honeywell, this non-ozone depleting, mildly flammable refrigerant (A2L ASHRAE), much like R32, is an alternative to R-22 as well as the R-410A due to its low global warming potential (vs. both R-410A and R32). The L-41y (R-452B) was launched in Sept 2018, a non-ozone depleting, mildly flammable, zeotropic blend for positive displacement comfort air cooling and reversible heating applications, with 67% lower GWP than R-410A and design compatibility allowing for a faster transition from R-410A.

R134a/R123: R134a is the most commonly used refrigerant in chillers, with R123 used primarily for centrifugal chillers.

Solstice ze (HFO 1234ze): A proprietary product by Honeywell for refrigeration, this refrigerant is an alternative to R134a and is used primarily in chillers, CO₂ cascading systems, air dryers, and heat pumps. It has a GWP of as low as 6. The recently introduced N-15 is a nonflammable azeotropic blend designed for chillers, heat pumps, and high ambient air conditioning systems, with a GWP of 292, while its

similar product design to R1234ze provides a long-term solution that is suitable for both A1 and A2L refrigerants.

Solstice N-41 (R466A - provisional): A proprietary product by Honeywell, this non-ozone depleting refrigerant is an alternative to R410a for stationary resi and commercial air conditioning systems, and is the only replacement option that is non-flammable (preliminary A1 ASHRAE) with 60% lower GWP than R-410a at 733. The refrigerant presents a close performance match and energy efficiency equal to or better than R-410a, and is compatible with existing R-410a equipment design. According to Toshiba Carrier's findings, N41 life-cycle climate performance is 30% lower than R-410A, and design pressures are slightly lower so the reduced need for system redesign lowers conversion cost.

Opteon XL41 (R-454B): This Chemours refrigerant is a mildly flammable (A2L), non-ozone depleting alternative to R-410A, with the lowest GWP of 466 (78% below R-410A), for resi and commercial air conditioning heat pumps and chillers. This refrigerant does not offer retrofitting from R-410A, and requires additional sensors due to its lower 2L flammability rating.

Table 119: Refrigerant Comparisons

Refrigerant	GWP (CO2 = 1)	Flammability	Ozone Depletion Potential	Notes
R-22	~1800	Non-Flammable	Some	
R-407C	~1800	Non-Flammable	Zero	No equipment changeover from R-22
R410A	~2100	Non-Flammable	Zero	Requires Equipment changeover from R-22
R32	~675	Mildly Flammable	Zero	Requires Equipment changeover from R-22 but not from R410A
R-452B	~700	Mildly Flammable	Zero	Requires Equipment changeover from R-22 but not from R410A
R-446A	~730	Non-Flammable	Zero	Preliminary A1 classification. Expected to be easily converted from R-410A
R-454B	~470	Mildly flammable	Zero	Requires some new equipment from R-410A due to flammability

Source: Honeywell, Emerson, Chemours, JARN

New refrigerant regs deadline looming in 2023

The next year will be critical for OEM decisions around which new refrigerant they will develop their new unit models around, in response to California's ruling that bans R410A in new equipment in 2023. While the deadline is in 2023, the system designs are in process, and much of the industry development dollars will be spent on getting this right, along with the new SEER regulations coming in the same year. New choices here are the mildly flammable 454B (Chemours) and R32 or the non-flammable R466 (Honeywell). There are positives and negatives to both. Because of the risk around flammability, 454B/R32 will require extra sensors throughout the building, while R466 would not. That said, despite the need for additional sensors on installation, 454B/R32 are, according to many we spoke with at AHR Expo, more "plug and play" from an equipment and supplier assembly/manufacturing perspective, and Honeywell's R466 product is facing hurdles around working with certain materials, requiring some extra design tweaks/engineering to key components. The outcome remains a TBD, but Carrier formally committed to 454B for unitary products. What will be used for mini-split applications is still a TBD, for which non-flammable characteristics are more important given the greater movement of refrigerant. Most recently, California became the first state to adopt regulations

that will phase down the use of HFC refrigerants in commercial and industrial stationary refrigeration units, such as those used by large grocery stores, as well as commercial and residential A/C equipment. Under these new rules, starting in 2022, there is a 150 GWP limit for new or fully remodeled facilities that utilize commercial refrigeration equipment containing more than 50 pounds of refrigerant; there are varying requirements for existing facilities. The 750 GWP limit for many types of air conditioning equipment was pushed back from 2023 to 2025, while VRF system manufacturers have until 2026 in order to comply with the new limit given that current building codes and standards do not allow the use of lower flammability (A2L) refrigerants in equipment.

Table 120: Refrigerant Replacement Options to R-410A

Refrigerant	Manufacturer/Product	Flammability	Global Warming Potential (GWP)	Characteristics
R454B	Chemours/Opteon XL41	mildly flammable	~80% lower than R-410A	requires additional sensors on installation due to flammability; more "plug and play" from an equipment & supplier assembly/manufacturing perspective
R466A	Honeywell/Solstice N41	non-flammable	~60-65% lower than R-410A	easily convertible; requires minimal equipment changes and no additional training for installation techs; some compatibility problems with certain materials
R32	various	mildly flammable	33% less than R-410A	relatively high discharge temperature; additional sensors required on installation

Source: Company reports, JARN

Previously, R32 had become the LGWP refrigerant of choice for smaller AC systems as a medium-term alternative to R410A, but its mildly flammable aspect makes it unsuitable for larger systems. R32/454B, therefore, will require extra sensors throughout the building on installation, while R466 wouldn't, but there is still some work to do on developing a package that works with key system components to improve the "plug and play" nature. Indeed, and somewhat curious on timing, Carrier, the first OEM to commit, is going with Chemours for its solution in ducted products, despite its flammability, which means added sensing apparatus in the home/building, given more limited need for re-designs throughout the supply chain. Still, HON said that its design provides for less complexity in system installation, with minimal changes to equipment and no additional training for installation and repair technicians, allowing OEMs to easily convert from R-410A. They also cited lower costs of transitioning to Solstice N41 compared to converting to a flammable refrigerant. Although the refrigerant remains in trials and needs work around packaging and system to work with system components, Daikin expects non-flammable refrigerants to win out. Daikin also said that it was employing AI technology to develop a new mildly flammable refrigerant (A2L) with GWP of 10 or less, to be introduced in 2023. On the OEM customers' side, HON believes OEMs will be able to choose to work with more than one refrigerant, and Carrier indeed left the option open for its other types of equipment (such as VRF) and said it will select the best suited refrigerant as the need arises. Lennox is holding off on making a call between R454B and R32, and mentioned hearing of shortfalls on capacity rates during tests of R466. EMR cited seeing a lot of competing refrigerants, and they see themselves as well positioned to lead through the transition as they boost their sampling and prototype activity to support OEMs' resource shift.

R-22 phase down and pricing trends

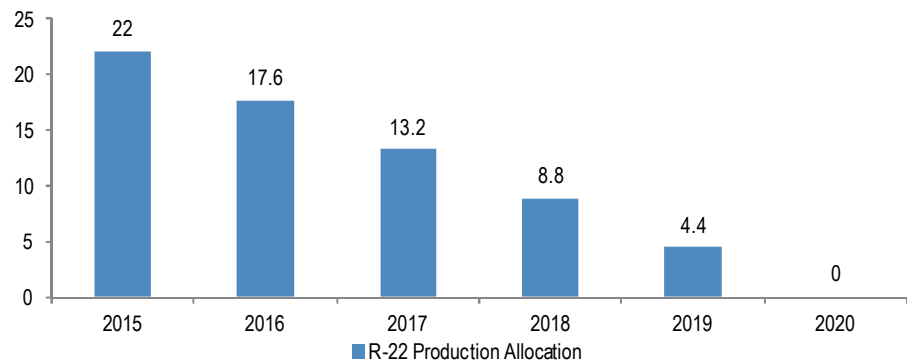
In the U.S., regulation on HFC came in the form of the SNAP program (significant new alternatives policy), to phase out ozone depletion chemicals (such as R12, R22). EPA used this policy to delist some refrigerants, however a lawsuit in 2016 saying that EPA didn't have the authority to delist or regulate high GWP refrigerants led to

a US district court ruling against EPA. Still, individual states such as California are now proposing SNAP rules into their own state laws to regulate the refrigerants.

In October 2014, the EPA finalized its Allocation Rule governing the phase-down of R-22 production, opting for the most aggressive five-year phasedown contained in the proposed rule. The Allocation levels (in mm/lbs) from 2015-2019 are 22/17.6/13.2/8.8/4.4, respectively, with no virgin production by 2020. This has been supportive of prices as it provides a clear path to reduced production allocations through 2020; in other words, it reduces the risk of unexpected upticks in supply, as we saw in 2013 when Arkema was given a temporary increase in production allowance. Previous EPA guidelines had not provided full visibility into the 2016-20 lower progression.

Figure 350: R-22 Production Allocations (2015-20)

Million pounds of R-22 production/consumption allocations

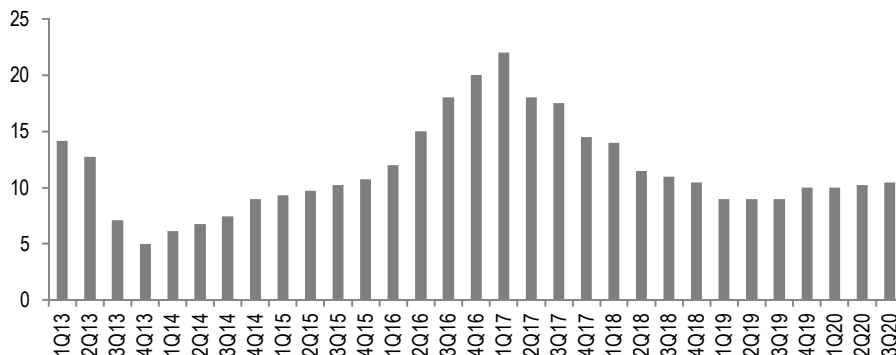


Source: EPA, J.P. Morgan

Although we are not aware of any direct, regular pricing on R-22 gas, feedback from the channel and major R-22 producers showed that pricing generally rose from 2H14 to 1Q17, and has trended down since. Hudson Technologies (a company that offers recovery and reclamation of refrigerants) reported a price increase of ~20% for R-22 following the final EPA ruling and reported further increases throughout 2015 and 2016. 2017, however, saw steady declines throughout as the company cited disruption from a competitor aggressively putting new product into the market. In 2018, R-22 pricing continued its downward trend from \$14-15 per pound in 4Q17 to ~\$11-12 in May, to \$10-11 in August (HFC pricing down 40% q/q in 2Q) and remained in that range through December, according to Hudson. In March 2019, R-22 pricing was down further to \$9 per pound, and as of the end of the summer selling season in 2020 it has moved back up above \$10.

Figure 351: Estimated R-22 Refrigerant Prices (Industry Average)

\$/lb



Source: Hudson Technologies, J.P. Morgan estimates

Anecdotally, R-410A pricing has been relatively stable in the recent past, though competition from China has intensified. In July 2015, the American Hydrofluorocarbon Coalition, a group of refrigerant suppliers including Honeywell, Arkema, Chemours, Hudson, Worthington, and Mexichem, filed an antidumping duty petition with the US Department of Commerce and the US International Trade Commission. The coalition alleges that Chinese imports are being aggressively sold at below market prices with dumping margins for various HFC blends (R-404, R-407A, R-407C, R-410A, R-507A, R-32, R-125, and R-143a) ranging from 100-300%. According to the petition, imports from China increased by 60% from 2012 to 2014 and continue to increase, resulting in falling prices and US suppliers losing market share. The US Department of Commerce issued an affirmative preliminary determination in January 2016 and an affirmative final ruling in June 2016 that HFC refrigerants from China have been sold in the US at dumping margins ranging from around 100-210%. A similar petition was filed in March 2016 regarding R-134a, reprising a 2013 petition from Mexichem that was ultimately ruled against by the US ITC, and has received an affirmative preliminary ruling.

R-22 to R-410A the most significant and common transition

As background, the transition to R410A in Jan 2010 came in the context of a long-growing awareness around the environmental damage done by emissions of older refrigerants. The target of regulators was principally CFCs, or chlorofluorocarbons, and HCFCs, or hydrochlorofluorocarbons (the presence of chlorine is the key negative that causes destruction of the ozone layer). While theoretically the R410A has higher GWP (global warming potential), it has less ozone-depletion potential, which is why, as per the Montreal Protocol, various regions mandated a transition away from R-22, albeit with different timelines. The transition, however, was not very smooth and required a redesign of heat pump and air conditioning systems. New systems incorporate compressors and other components specifically designed for use with specific replacement refrigerants. For instance, if a new outdoor unit (typically called a “condensing unit,” containing the condenser and compressor) is installed, it is likely that a new indoor unit (typically called an “evaporator”) will also be required.

On the competitive front, this shift has led to a less competitive environment as there are fewer suppliers of R-410a refrigerants in the marketplace than there were of R-22, which was a more commoditized product.

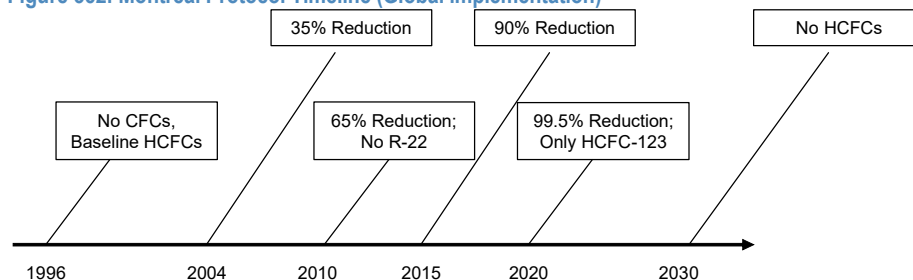
Table 121: Refrigerant Transition Summary

Refrigerant Type	CFCs	HCFCs	HFCs	LGWP
Characteristics	Ozone Depletion Potential Very High Global Warming Potential	Reduced Ozone Depletion Potential High Global Warming Potential	Zero Ozone Depletion Potential High Global Warming Potential	Zero Ozone Depletion Potential Low Global Warming Potential
Competition	Fragmented Industry Participants Low Barriers to Entry	Many Industry Participants Low Barriers to Entry	Several Industry Participants High Technology Needed Intellectual Property Critical	Select Industry Participants High Technology Needed Intellectual Property Critical

Source: HON company reports.

The Montreal Protocol, an international environmental treaty intended to phase out production of ozone-depleting substances, set a series of firm deadlines to move to more environmentally friendly refrigerants. Different regions have adopted different timelines, and the most recent big move has been in the US, where effective January 1, 2010, OEMs were no longer allowed to ship newly manufactured equipment using R-22 refrigerant.

Figure 352: Montreal Protocol Timeline (Global implementation)



Source: Montreal Protocol.

Motors

Motors make up ~10% of total cost of an AC unit and are an important component just like compressors and refrigerants. Motors are used to run the blowers that circulate air through the system. Market dynamics are similar to those of compressors, but room for advancement in technology and differentiation is relatively less. The HVAC motor market is fairly consolidated, with the top suppliers being Regal Beloit (which also owns A.O. Smith, a former competitor) and Emerson Electric.

Types of Motors

To achieve heating or cooling, an HVAC system depends heavily on the quick movement of air from one location to another. AC motors have been used in past applications to serve as the primary air driving force, but they are not always the most efficient choice because they run continuously at full power. Electronically commutated motors (ECMs) were developed to offer a large variation in functioning, and higher energy savings.

Fixed (PCS): PCS motor technology has been the standard in the industry for many years and was typically positioned by most manufacturers as a standard product offering for HVAC applications. These products are generally simple to install, reliable, have low cost, and are flexible. PSC motors are considered single-speed because they do not have any internal controls that can be programmed to automatically vary the rotation of the motor over an operating range. They are AC motors that were used in past applications to serve as the primary air driving force, but they are not always the most efficient choice because they run continuously at full power. On starting, a typical PSC motor almost immediately runs at full capacity and stops suddenly when switched off, resulting in inefficient energy usage.

Variable (ECM): ECMs are DC motors that function using a built-in inverter and a magnet rotor, and as a result they are able to achieve greater efficiency in air-flow systems than some kinds of AC motors. A typical ECM operating in an HVAC system will go through several stages, as determined beforehand by a manufacturer or a preprogrammed controller. Although ECMs are often selected because many models run at variable speeds, in certain condenser applications it is preferable to select an ECM that runs at a fixed speed as well since it uses less energy than a typical PSC motor running at a fixed speed. In other HVAC units, an ECM can run at variable speeds but depends on a controller that pre-programs speed, including the rate at which the motor ramps up.

Overall motor market

Electric motors are key components in many durable goods including HVAC equipment. According to a 2014 study by Freedonia group, demand in the United States for electric motors (including HVAC) is expected to increase 5.4% annually through 2018 to \$16.2B, accelerating from the pace of the 2007-13 period, when nearly every major market for these devices struggled. Among major markets, heating and cooling equipment (primarily HVAC systems) applications are projected to register among the fastest sales growth through 2018.

A fairly consolidated industry—a quick look at major players

The electric motor market is fairly consolidated with Regal-Beloit, Emerson, and ABB the largest players. Note that the industry saw consolidation, with Regal Beloit acquiring the motors business of A.O. Smith and ABB buying Baldor, both in 2011. Prior to that Regal Beloit also purchased a major vendor, Fasco Motors, which makes AC motors, DC motors, and air blowers.

Regal-Beloit: This is one of the largest and one of the closest pure-play electric motor vendors in the industry. Regal became a global player in this market post the acquisitions of GE's Commercial AC and HVAC motor businesses, which had combined annual revenues of ~\$600mm. In 2011 the company acquired A.O. Smith's Electrical Products Company for ~\$875mm, which added ~\$700 mm in revenues and expanded the company's manufacturing footprint in Mexico and China.

Emerson/Nidec: This is also one of the largest electric motor manufacturers and was part of the company's Industrial Automation segment before being sold to Nidec. The company sold the HVAC motors internally into the company's Climate business segment and had a large product variety that includes appliance motors, DC motors, fractional horsepower motors, integral horsepower, and larger motors.

Baldor (ABB): Another leader in the electric motor market, which also manufactures mechanical power transmission products and drives. It was acquired in 2011 by ABB for \$4.2B (~\$2.1B in sales) but still operates under the Baldor Electric brand.

ECM is to Motors what VRF is to Compressors

Today's higher-efficiency equipment, both furnaces and ACs, are now using new higher efficiency motors to reduce the total electrical consumption of the system, thus raising the efficiency. They also help with the efficiency by maintaining the proper air flow (CFM) across components like evaporator coils, heat exchangers, and even condenser coils.

ECM stands for *electronically commutated motor* and is also referred to as a variable speed motor. ECM varies the RPM (speed) of the motor in response to changing conditions in the system. Just like the analogy we used for the inverter technology in compressors, an ECM motor works like a cruise control on a car; the only difference is instead of the MPH (miles per hour, in a car), the motor keeps the CFM in an AC in check.

Primer IV: The Basics of HVAC Margins

This section provides some of the basic overview of margin dynamics for unitary HVAC players. We focus largely on the residential market, but the majority of this analysis would also apply to light commercial product sold through distribution (commercial applied has similar dynamics on material costs but has a more complicated selling channel).

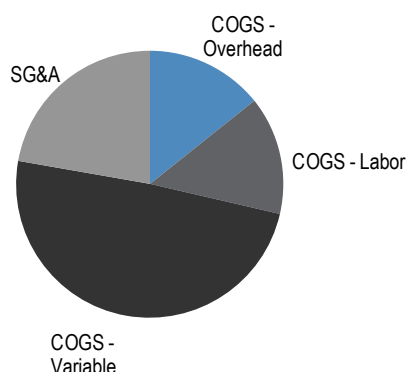
Understanding the Margin Levers

Volume/fixed cost absorption

Like all manufacturing business, fixed cost leverage plays a significant role in margin swings, albeit perhaps less so than in some other industries. On average, we estimate that ~20% of the total of a typical OEM's costs is relatively fixed, a combination of labor and manufacturing overhead. However, a large portion of costs is also variable, which is because of the significant amount of acquired components (compressors, motors, etc.) as well as logistics costs.

Figure 353: Typical Residential HVAC OEM Cost Structure

% of costs



Source: J.P. Morgan estimates

Price/cost

The final variable is price/cost. As we've discussed before, we estimate a typical HVAC manufacturing business will have a ~30% gross margin with ~65% of COGS "metals-related," approximately 75% of which is components and 25% of which is direct purchases of raw materials. The illustrative model shows that in the face of inflation, OEMs can typically offset with some price. As per the below, every point of price will offset about 6% raw materials cost inflation.

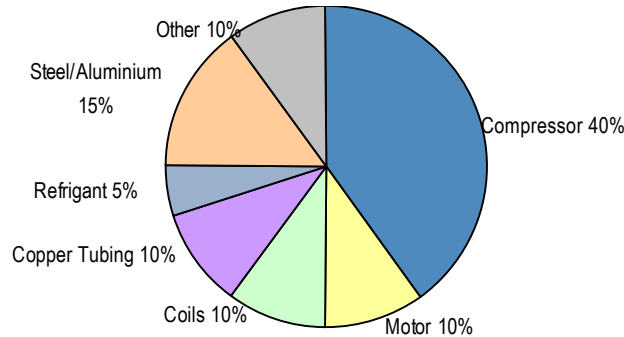
Table 122: An Illustrative Model Shows That 3% of Price Can Offset Significant Inflation

		y/y	Price
Sales	100	1	1.0%
Cogs (70% sales)	70		y/y
Metals Related (65% COGS)	46	1	2%
o/w Components (75% of "Metals Related")	34	0	1%
o/w Direct Raws (25% of "Metals Related")	11	1	6%
Net Profit Impact			0%

Source: J.P. Morgan estimates

Figure 354: Total Unit Cost

% of total unit cost



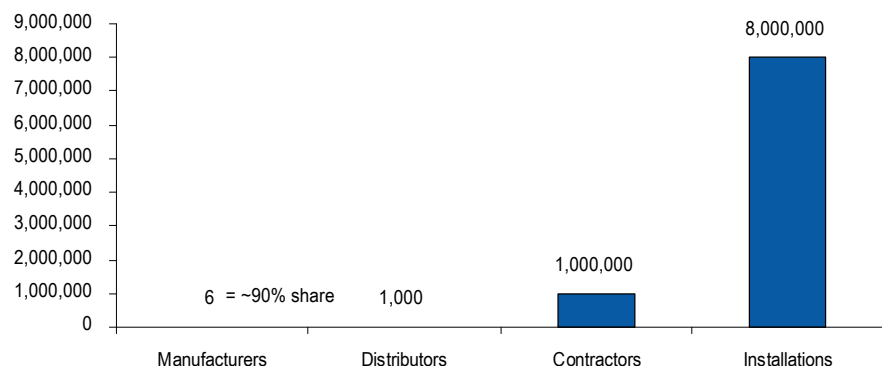
Source: J.P. Morgan estimates

Price/cost Volatile in the Short Run, but Enough Pricing Power to Maintain Balance Over the Medium Term

Distribution model helps drive pricing strength

We think pricing power is largely a function of the industry's favorable distribution structure. First, with the top six OEMs holding nearly 90% of market share, there is significantly more pricing power relative to the broader distribution base, which, in turn, has pricing power against an even more fragmented set of contractors. Second, because the installation of HVAC equipment must be done by a licensed contractor, consumers cannot easily compare prices in a retail setting, making demand less elastic to small price changes. Finally, it is important to keep in mind that many dealer-contractors tend to stay loyal to a limited number of OEMs (often one brand per price point), making them less likely to base their decisions purely on price. To be sure, bidding is competitive at the dealer level and distributors get pushback but not typically in a way that fully offsets OEM pricing power.

Figure 355: Fragmented, Two-Tier Distribution System Is Key to Pricing Power



Source: Goodman Global

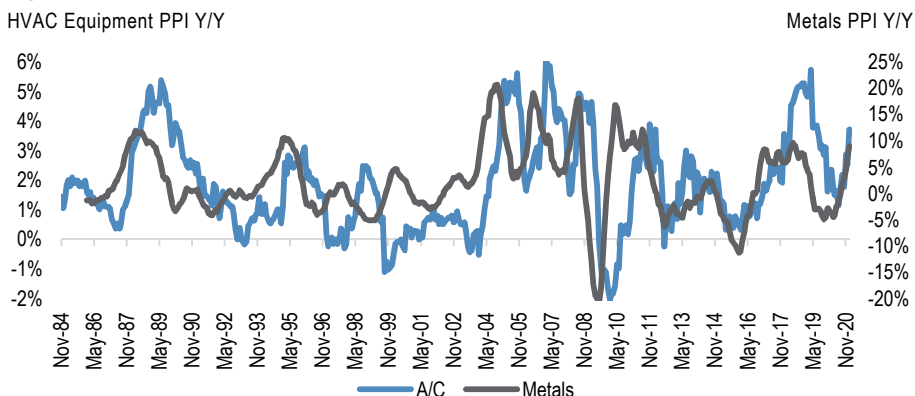
Price increases small in the context of overall system cost increases

It is also important to put a 2-4% price increase in perspective. As we discussed above, each increase in the minimum SEER efficiency can add ~10% of system costs, and the additional component and labor cost associated with an R410A system replacement can be an effective ~100% price increase. This dwarfs the incremental impact of a commodity-driven price increase. Additionally, keep in mind that the typical consumer purchases a new system only every ~15 years; so, the consumer often has little reference point on what a system “should” cost. To be sure, we are concerned about demand destruction from higher-priced units, but this is more about long-term structural factors than a small price increase in any given year.

OEMs typically get squeezed during rapid inflation, re-capture margin during deflationary periods

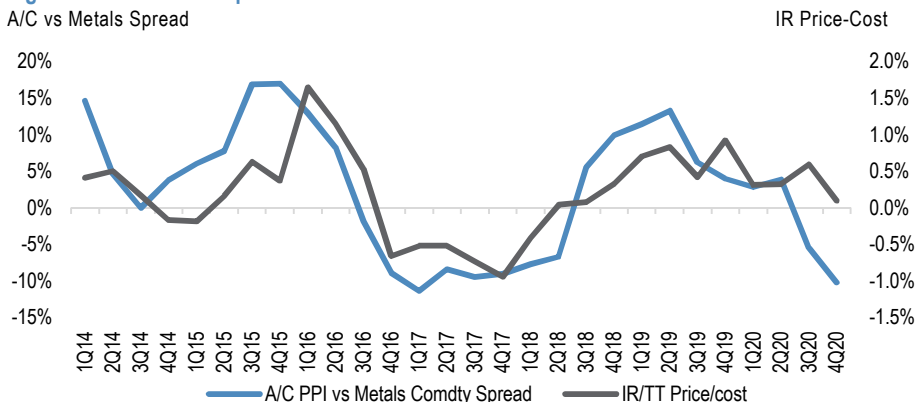
The risk is that in periods of rapid inflation, like 2010, the OEMs will have to temporarily absorb a negative price/cost spread that may not necessarily be made up in the following year. As shown in the charts below, there tends to be a lag of as much as a year between metals inflation and HVAC pricing. On the positive side, however, HVAC OEMs typically don’t give back pricing during deflationary periods, meaning they can recoup some of this margin; this happened in 2009 as well as during 2012-15. The price/cost spread at OEMs would generally trend with but lag behind the moves in these indicators.

Figure 356: A/C PPI vs. Metals PPI



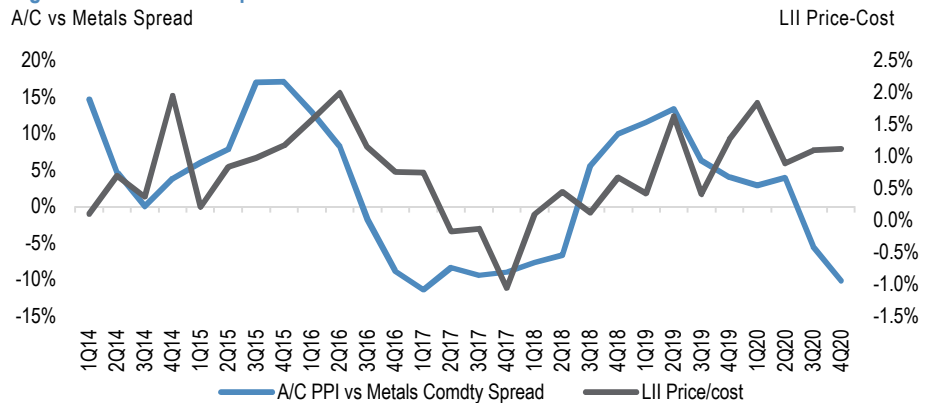
Source: BLS.

Figure 357: Price-Cost Spread vs IR/TT



Source: BLS, Company reports

Figure 358: Price-Cost Spread vs LII

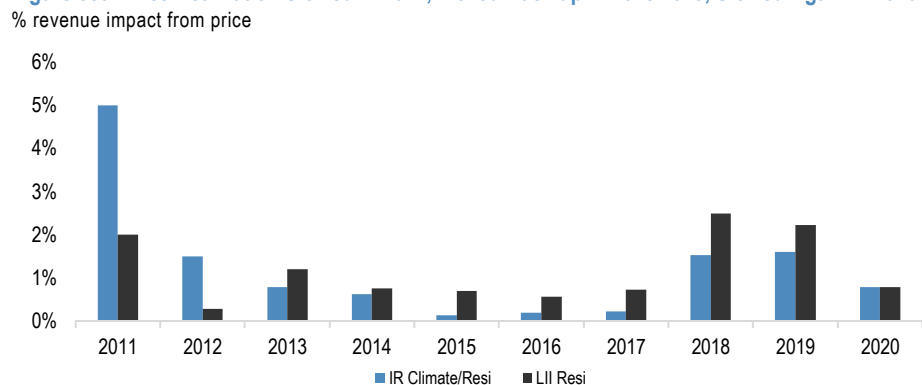


Source: BLS, Company reports

2011 showed that industry price discipline remained intact; 2018/2019 another proving ground

We believe 2011 was a good “stress test” for the industry in terms of its ability to respond to rapid material inflation. Nearly all of the OEMs, including leading value manufacturers such as Goodman, introduced their standard early season price increases. Additionally, there was a wave of second price increases mid-season, also done fairly consistently across the industry. 2018 was another proving ground for the industry’s ability to push price. Entering 2018, OEMs came out with somewhat more aggressive price increases given commodity prices, with quoted increases in the MSD range given higher commodity prices and tariffs, and with carry-overs from 2018 price increases, pricing and inflation comps lapping late in the year, most companies succeeded with price offsetting or at least covering cost in 2019 as well. Typically, OEMs end up realizing less than the stated price increases, but with commodities picking up we would expect a more concerted effort to realize price increases this year as an offset.

Figure 359: Price Realization Slowed in 2012, Picked Back up in 2018-2019, Slowed Again in 2020

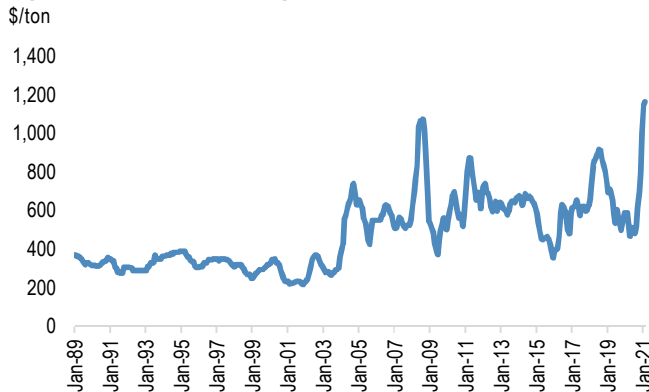


Source: Company reports (Note: IR re-segmented after 2012, chart data is IR Resi in 2011/2012, IR Climate from 2013 onwards)

Commodity cost inflation has returned

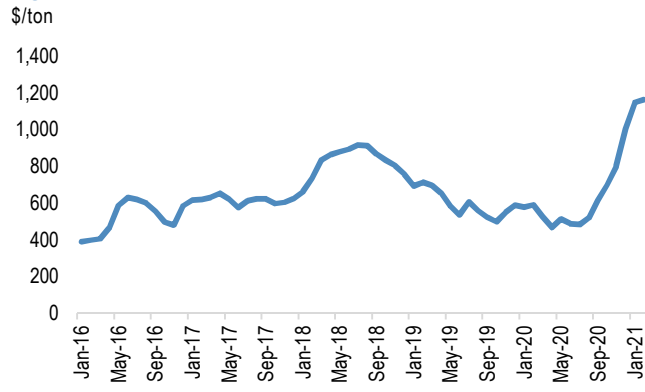
After a period of commodity deflation, steel and copper picked back up in the latter half of 2020 and remain high currently. OEMs have largely offset inflation effects with price increases in the past (i.e., a distributor could show an HVAC customer the chart on copper if it got pushback of price), but typically with some lag so if commodities shoot up rapidly there may be a brief period of squeeze.

Figure 360: Steel Prices (Long-Term)



Source: Bloomberg Finance L.P.

Figure 361: Steel Prices (Short-Term)



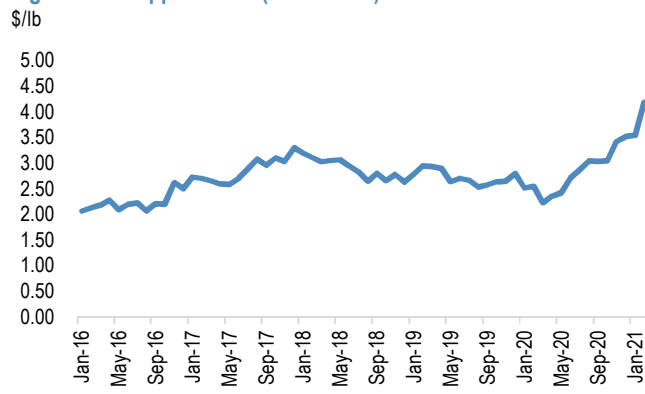
Source: Bloomberg Finance L.P.

Figure 362: Copper Prices (Long-Term)



Source: Bloomberg Finance L.P.

Figure 363: Copper Prices (Short-Term)

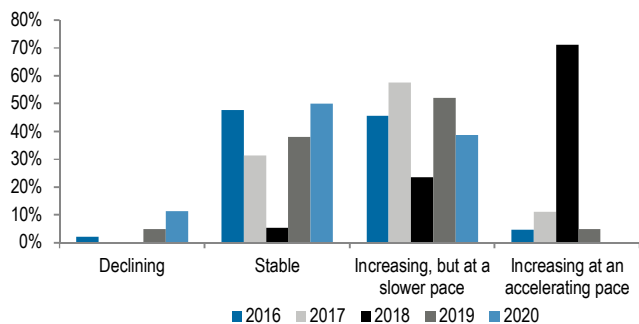


Source: Bloomberg Finance L.P.

Price increases slowed in 2020

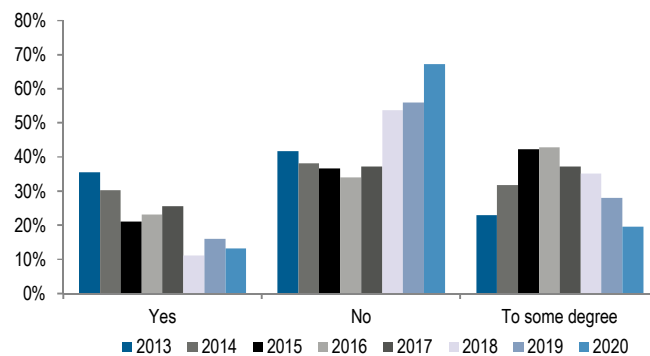
As per our 2020 HVAC Survey (open between 6/24 and 7/02), most OEMs were still realizing positive price last year, albeit to a lesser degree than in 2019. Raw material costs began to fall after a strong rebound in 2017/2018, with many respondents (~39% vs. 52% last year) indicating raw material price movements from OEMs are increasing at a slower pace in 2020, while ~50% of respondents saw price movements as stable, suggesting OEMs lost some pricing power. Not surprisingly, also in-line with the above, fewer respondents (~13% vs. 16% last year) saw price concessions from OEMs, while an increasing number of respondents (~67% vs. ~56% last year) saw no concessions at all and ~20% saw concessions to some degree (vs. ~28% prior).

Figure 27: Raw materials related price movements from OEMs are...



Source: J.P. Morgan, HARDI

Figure 28: Are you getting price concessions on equipment from the OEMs?



Source: J.P. Morgan, HARDI

Industry Margins Continue to Rise

Coming out of the recession, the HVAC industry was generally aggressive in taking out cost and capacity to effectively compete in a world with lower volumes. Volumes have since returned, and margins have improved solidly almost across the board and are now back above prior peak levels. Positive price/cost trends have helped, along with company-specific supply chain initiatives and better operations, as well as aggressive restructuring at many key players. With commodity costs moving up sharply in the last several months, we see potential for some near-term price/cost pressure as a partial offset to expected volume growth.

Table 123: Historical Operating Margins of Major HVAC Players

% segment operating margin as reported (may not be comparable)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Trane	n/a	11.3%	9.9%	5.6%	7.7%	8.4%	9.0%	10.4%	12.1%	12.7%	14.5%	14.1%	14.3%	14.6%	14.6%
LII Commercial	9.7%	11.5%	11.2%	8.3%	11.2%	11.3%	12.7%	14.0%	14.1%	14.7%	16.3%	16.2%	17.5%	17.5%	17.1%
LII Resi	11.4%	10.4%	9.8%	8.6%	11.0%	7.0%	7.5%	11.4%	13.6%	14.9%	17.4%	17.5%	16.7%*	17.0%*	18.1%
Carrier ¹	8.4%	8.9%	8.7%	7.3%	9.9%	11.7%	14.2%	15.4%	16.5%	17.6%	17.5%	16.4%	15.8%	14.5%	13.7%
Goodman ²	10.1%	11.7%	7.5%	14.9%	16.2%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
JCI NA Systems + Service ³	7.8%	9.6%	10.2%	10.0%	7.6%	7.9%	9.9%	11.3%	10.5%	11.9%	11.9%	12.9%	12.4%	n/a	n/a
Avg	9.5%	10.6%	9.6%	9.1%	10.6%	9.3%	10.7%	12.5%	13.4%	14.6%	15.5%	15.8%	16.1%*	15.9%	15.9%

Source: Company data, J.P. Morgan analyst estimates. Note: *LII Resi 2018/2019 excludes insurance recoveries. 2018 average is ex-JCI.

(1) Prior Carrier reporting segment that includes Transicold and commercial refrigeration; segment discontinued in 2012 and now included in CCS segment while part of UTX (CCS margins from 2013 onwards)

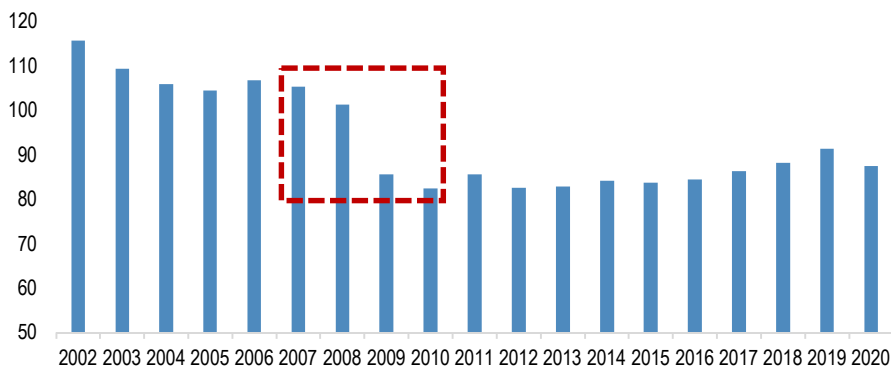
(2) Based on public filings through 3Q10 (2010 number is a trailing 12mo margin number); includes all allocated corporate

(3) Includes all allocated corporate

The industry spent much in restructuring last decade, as total employment in the HVAC industry (as measured by the Census NAICS category) declined ~18% from its most recent peak in 2007 to 2010, and has since remained in the same range. As background, we profile below the major restructuring programs seen at three of the “Big Five” HVAC OEMs: Carrier, Lennox, and JCI. Goodman was less pronounced in terms of restructuring as the company gained share through the downturn, though it still did flex down employee headcount in response to demand. Trane was also less pronounced but has improved operationally nonetheless.

Figure 364: US Census Bureau Data Show HVACR Employment Down 18% from 2007 to 2010

Employees (in thousands)



Source: US Census.

Carrier has been a high-profile restructurer

At UTX, there was lots of activity coming out of the recession. To review the Carrier initiative, the company took ~\$500 mm in cumulative restructuring, bringing headcount down 33%, overhead down by 28%, and factories down by 39% over 2008-10. About 40% of the 14,000 reduction in headcount was true rightsizing, de-layering, and low-cost sourcing, with the rest from the sale of non-core assets, ultimately getting rid of around \$3B in sales that were earning a low margin. On this front, Carrier rationalized its company-owned distribution network, setting up lucrative JVs with Watsco and others, which resulted in a doubling of margin for related business. It also sold non-core businesses, the most visible of which was Tyler Refrigeration, and others that included Howden Compressors and MagicAire. Lastly, the company reduced its exposure to the highly competitive international residential verticals. The business was spun off into a separate entity last year, and we expect ongoing refinement of the portfolio post-spin.

Table 124: Key Cost Reduction Metrics for Carrier Restructuring Programs

Change from peak		
Employment	44K to 30K; -32%	
% from core cost structure	45%, or 6K or 14%	
Executives	270 to 140	
Factories	58 to 30; -48%	
Floor space	n/a	
Overhead	21% to 17%; -28%	

Source: Company data

Table 125: Summary of Key Carrier Actions

Carrier Actions		Notes
Exited non-core businesses	29% of businesses earning 1% margin, ended up selling \$3 B	
Cut int'l resi exposure	Toshiba deal	
Distribution partnerships	Carrier Enterprises deal, on which margins +2x	
Core restructuring	\$520 mm of cumulative spending	
Baseline productivity	\$450 mm in savings from product cost reduction, low-cost regions, among other things >lowered resi/light commercial breakeven from 49% to 24% of capacity	

Source: Company reports, J.P. Morgan

Lennox has quietly been active in reducing structural cost

Lennox has also taken fairly aggressive cost-reduction moves over the last several years, reducing employment by ~40% versus the peak (actions that include the addition of a low-cost manufacturing site in Mexico). Like Carrier, Lennox also underwent an extensive review of its supply chain, driving significant savings from sourcing as well as product redesign. Additionally, the company has rationalized its company-owned distribution assets, shifting away from one national distribution center to regional hubs that support the additional PartsPlus branches.

Table 126: Key Cost-Reduction Metrics for Lennox Restructuring Programs

Change from peaks		
Employment	16K to 10K; -35%	
% from core cost structure	n/a	
Sourcing and product redesign	~\$35mm annual gross saves	

Source: Company data

Goodman: footprint consolidation a key watch item

Goodman was the share gainer last cycle and through the downturn, perhaps reducing the need to take out significant amounts of factory space (total square footage was flattish over the period). The company did consolidate some facilities on the flexible duct side and also flexed down its manufacturing employees by ~20% over this period, showing it had adjusted its cost structure to the lower volumes. Note that Goodman's last detailed public filing came in 2010. Looking ahead, Daikin has consolidated its footprint and opened a megafactory in Houston. The Daikin Texas Technology Park spans over 4.2 million square feet of space (4.1mm sq ft of operational space). The factory employs thousands of engineers, welders, fabricators and warehouse workers, and produces the bulk of the Goodman, Daikin and Amana A/Cs and heating units sold in the US/Canada. Goodman has said that they would consolidate 3500-4000 workers from other Daikin plants, but could also hire 5000 by the time facility is built, and would hire 2000 between 2018-2020. The \$417mm, 94-acre plant is the second largest industrial building in the US behind Boeing's jetliner-assembly plant, and covers the entire production line from raw materials to finished products. The plant also includes 200K square feet of laboratory space for R&D, with fortified chambers to test different climate conditions on heating/cooling units, such that products can be tested, manufactured, assembled and distributed across North America under one roof.

With the factory now mostly up and running, the impact on the cost structure is a key TBD. Daikin will likely be able to leverage scale better than competitors, but competitors with factories in Mexico should enjoy lower labor costs, and if the tradeoffs here end up resulting in a cost advantage, we could see some near-term dislocation on price.

Table 127: Goodman Employees & Floor Space

	End-2006	March 2010	New Plant
Employees, total	4,878	4,466	
% chg		-8%	
Employees, manufacturing	3,202	2,570	Could add 5,000
% chg		-20%	
Floor space (sq feet)	3,041,389	3,108,262	~4,200,000
% chg		2%	

Source: Company reports

Table 128: Goodman Property Footprint (March 2006)

Location	Use	Owned/ Leased	Approx Sq. Footage
Houston, TX	Split Systems	Owned	518,000
Houston, TX	Flexible duct, insulation, etc	Owned	400,000
Houston, TX	Heating and Air Handlers	Owned	230,000
Houston, TX	Research and Development	Owned	99,188
Houston, TX	Corporate Headquarters	Leased	51,000
Houston, TX	Logistics Center	Leased	700,039
Fayetteville, TN	Multiple product lines	Owned	780,000
Dayton, TN	Air Handlers / Coils & Duct	Leased	159,000
Phoenix, AZ	Flexible Duct	Leased	39,062
Groveland, FL	Flexible Duct	Leased	65,100

Source: Company reports

Table 129: Goodman Property Footprint (March 2010)

Location	Use	Owned/ Leased	Approx Sq. Footage
Houston, TX	Split Systems	Owned	525,103
Houston, TX	Flexible duct, insulation, etc.	Owned	390,000
Houston, TX	Heating and Air Handlers	Owned	225,295
Houston, TX	Research and Development	Owned	156,703
Houston, TX	Corporate Headquarters	Leased (1)	61,698
Houston, TX	Logistics Center	Leased (2)	969,843
Fayetteville, TN	Multiple product lines	Owned	779,620
Dayton, TN	Air Handlers / Coils	Leased (3)	188,5

Source: Company reports

COVID-19 cost actions: JCI the standout in 2020

With the onset of COVID-19, restructuring efforts were renewed, with all major HVAC players focusing on short term relief through headcount reduction, furloughs, salary cuts, and discretionary costs, managing decremental margins well despite significant volume declines. The average decremental margin for calendar 2Q20 (the trough) was ~25% for the sector, while for the year we saw ~35% (note this excludes restructuring). The best decremental margin story came from JCI, with the company seeing HSD decremental margin for 2020. The other HVAC names in our coverage were all over the map. TT stood out positively (13% decremental), and CARR on the negative side (45% decremental). LII had the worst reported decremental for the year (75%), but this would be ~3% adjusted for insurance benefits in 2019 results (\$99mm total). Below we show decremental margin performance in the trough sales quarter (2Q) and for CY20 on the whole, as well as updated cost take out schedules.

Table 130: 2Q/CY20 Decremental EBIT Margins

	2Q20 (trough sales)	CY20
CARR	34%	45%
JCI	9%	8%
TT	23%	13%
LII	31%	75%*
Average	24%	35%

Source: J.P. Morgan estimates, Company data.

Table 131: Company Cost Action Guides

	2020 Total	Temporary	Structural
CARR	\$500mm	\$250mm	\$250mm (CARR 700)
JCI	\$500mm	\$400mm	\$100mm
TT	\$100mm	not disclosed	\$100mm
LII	\$40mm	\$40mm	-

Source: J.P. Morgan estimates, Company data.

JCI – The company executed well on planned cost mitigation, with best in class decremental margins. On the specific cost action, the company saw a total of \$500mm for the year, with \$300mm done in F3Q and the remaining \$200mm completed in F4Q. \$100mm of this is structural in nature, with \$400mm temporary with varying degrees coming back in 2021 based on topline performance. The \$400 of temporary cost mitigation is broken down into \$245mm from compensation, \$125mm of indirect spending, and \$30mm of facility costs.

Trane - Looking at Trane, the company posted decremental margins of 13% for the year. On cost actions to mitigate COVID-19 headwinds, the company realized ~\$100mm of cost reduction in 2020, and an additional \$40mm of savings in 2021 with a 2021 run rate of ~\$140 mm. The \$100mm of cost savings is made up of \$70mm within the businesses and \$30mm in corporate. The company also mentioned costs on the year, such as factory under absorption, and that the action taken in 2020 was mostly seen as a way of offsetting this cost, with some additional discretionary items such as travel that may or may not come back in 2021. Management noted that it is difficult to determine how much of the 2020 cost savings come back in 2021, and that much of it is top line dependent, although it is likely that not more than 50-60% comes back. Beyond this, the company has highlighted a plan to reposition IT and supply chain to deliver an additional \$160 mm in savings by 2023 one-third of which will be realized in '21.

CARR - Next, looking at CARR, where the main story is surrounding the Carrier 700 plan for \$700mm of structural cost take out through 2022, the company saw decremental margins of 34% in 2Q, but with a weak 4Q the year ended up around 45%, below expectations. On cost actions to mitigate COVID-19 headwinds, the previously announced Carrier 600 cost out schedule has been accelerated, and is now dubbed Carrier 700, and the company realized ~\$250mm of 2020 cost action from Carrier 700 (prior \$225mm), with an additional ~\$200mm from temporary mitigating actions such as salary cuts, travel reduction, headcount, with a ~\$100mm headwind from investment activity, which they have increased from the previously expected \$75mm due to improving market conditions. This brings the total cost action to ~\$350mm for 2020.

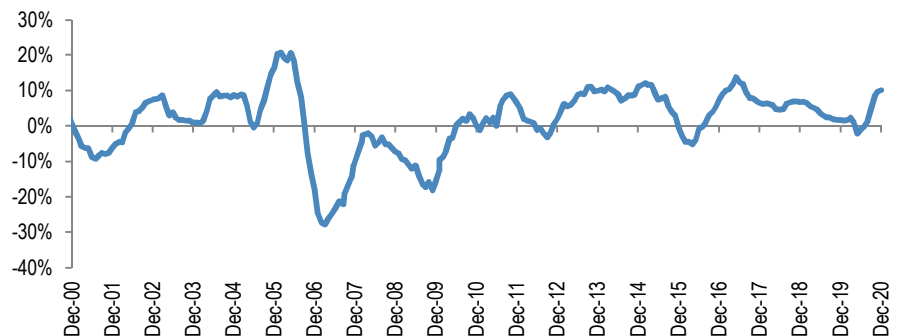
LI- For Lennox, decremental margin performance was solid adjusting for the insurance benefit in the base year 2019, with 3% for 2020. The company said 2020 SG&A cost savings were targeted at \$55mm, impacting 2Q-4Q, and for the full year SG&A ended up declining \$30mm, of which savings ended up being a \$40mm benefit. The company implemented the cost reduction May 1st starting with salary reductions. Additionally, the company noted that the degree that this cost comes back is dependent on top line and volume performance in 2021.

Appendix I: Recent Macro Data

Resi Demand: solid and stable growth

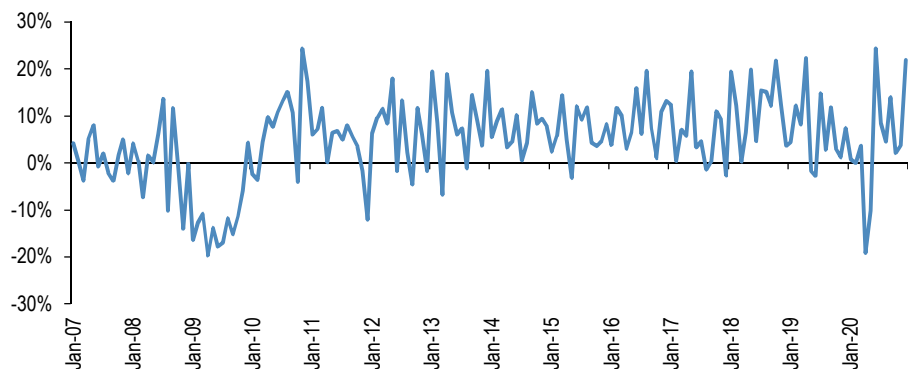
Residential HVAC demand has remained strong, continuing the industry's solid recovery over the past few years. 2019 growth for A/C and heat pump shipments was up ~2%, with 2020 up ~10%, while the HARDI distributor survey was up ~5.5% in 2019 and 3-4% in 2020 (this series generally diverges slightly from AHRI shipments since it also includes component and replacement part sales that are now lagging equipment).

Figure 365: A/C and Heat Pump Shipments Growth, 12-Month Rolling Average
Y/Y



Source: AHRI

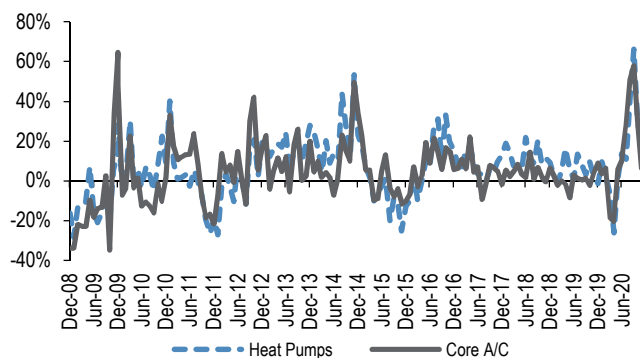
Figure 366: HARDI Monthly Distributor Sales Survey
y/y change



Source: HARDI

Figure 367: AHRI A/C and Heat Pump Shipments

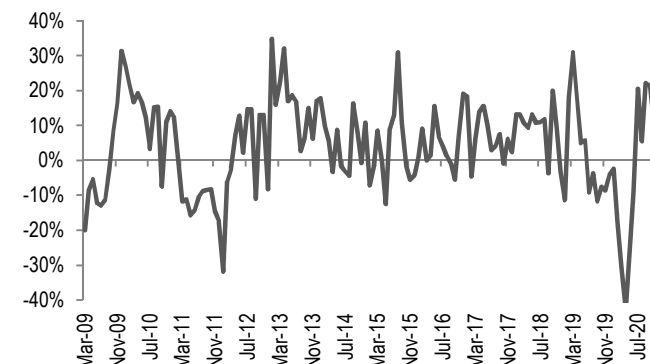
Y/Y change



Source: AHRI

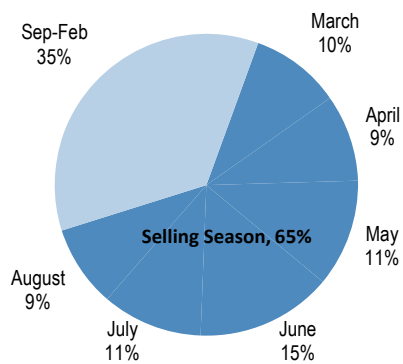
Figure 368: Monthly AHRI Furnace Shipments

% Y/Y



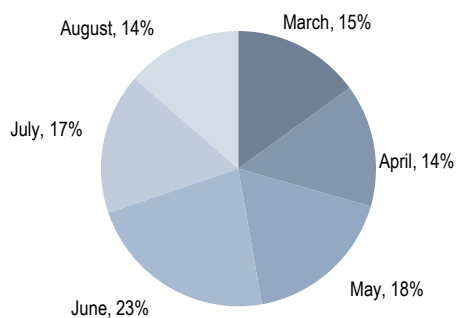
Source: AHRI

Figure 369: Unitary Volumes by Month (Historical Avg)



Source: AHRI

Figure 370: Summer Volume (Historical Avg)



Source: AHRI

Table 132: Total AHRI Shipments, Y/Y % Change and Seasonality

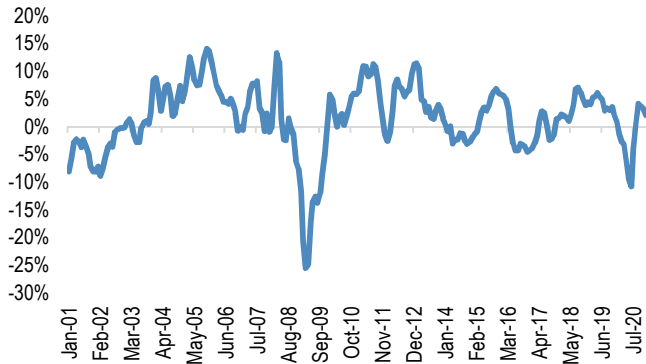
Thousands of units

Year	1Q	2Q	3Q	4Q
2003	1,516	2,350	1,807	1,132
2004	1,589	2,747	1,871	1,195
2005	1,669	2,503	2,502	1,935
2006	1,980	2,129	1,847	1,091
2007	1,349	2,247	1,737	1,074
2008	1,249	2,093	1,642	796
2009	959	1,808	1,454	919
2010	1,031	1,918	1,334	886
2011	1,203	2,087	1,476	740
2012	1,120	2,106	1,498	889
2013	1,229	2,309	1,639	993
2014	1,406	2,425	1,769	1,254
2015	1,631	2,289	1,780	1,114
2016	1,582	2,408	2,061	1,280
2017	1,712	2,674	2,060	1,360
2018	1,827	2,825	2,229	1,450
2019	1,861	2,821	2,303	1,485
2020	1,951	2,525	2,863	1,990
Y/Y % Change				
2004	5	17	4	6
2005	5	(9)	34	62
2006	19	(15)	(25)	(44)
2007	(32)	6	(7)	(2)
2008	(7)	(7)	(5)	(26)
2009	(23)	(15)	(11)	15
2010	7	6	(8)	(3)
2011	16	9	11	(16)
2012	(7)	1	2	20
2013	10	10	9	12
2014	14	5	8	26
2015	16	(6)	1	(11)
2016	(3)	5	16	15
2017	8	11	0	6
2018	7	6	8	7
2019	2	(0)	3	2
2020	5	(10)	24	34
% of Year				
2003	22%	35%	27%	17%
2004	21%	37%	25%	16%
2005	19%	29%	29%	22%
2006	28%	30%	26%	15%
2007	21%	35%	27%	17%
2008	22%	36%	28%	14%
2009	19%	35%	28%	18%
2010	20%	37%	26%	17%
2011	22%	38%	27%	13%
2012	20%	38%	27%	16%
2013	20%	37%	27%	16%
2014	21%	35%	26%	18%
2015	24%	34%	26%	16%
2016	22%	33%	28%	17%
2017	22%	34%	26%	17%
2018	22%	34%	27%	17%
2019	22%	33%	27%	18%
2020	21%	27%	31%	21%
AVG	22%	34%	27%	17%

Source: AHRI

Figure 371: HVAC Equipment Shipments (US Census Durable Goods)

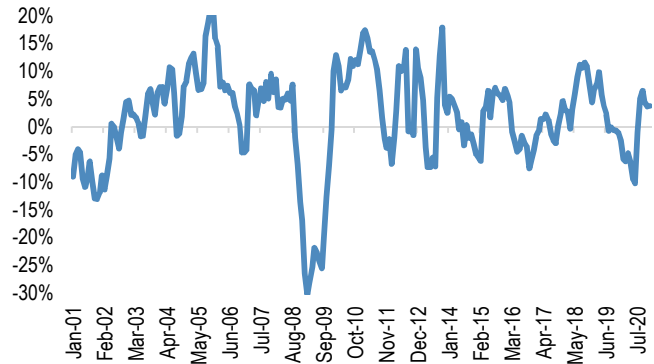
Rolling 3MA, Y/Y % Change



Source: US Census.

Figure 372: HVAC Equipment Orders (US Census Durable Goods)

Rolling 3MA, Y/Y % Change



Source: US Census.

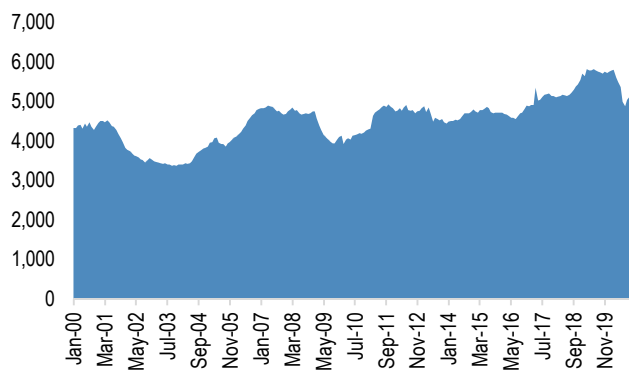
Inventories: low relative to sales

A large portion of residential and light commercial units sell through third-party distribution.

Inventories were taken down in 2020, but have recovered back to long-term averages on an inventory to sales basis. Looking back to the prior recession, inventories were lowered through the downturn and entered 2010 fairly lean even relative to the lower level of sales. There were periods in 2011-12 during which inventories had grown elevated, a combination of stocking ahead of OEM price increases, changes around the regulation of R-22 units, and weaker than expected demand. Inventories saw a bump at the end of 2014, likely as a result of 13 SEER pre-build, and then again in 2019 and were elevated into 2020 as the selling season in the prior year was weaker than expected before COVID-19 hit the economy.

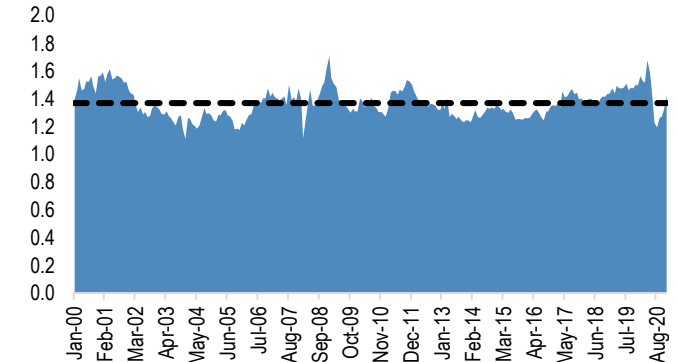
Figure 373: Absolute HVAC Inventory Levels Have Recovered...

\$, in mm



Source: US Census

Figure 374: ... And Are Back In Line With Long-Term Averages on Inventory/Sales



Source: US Census.

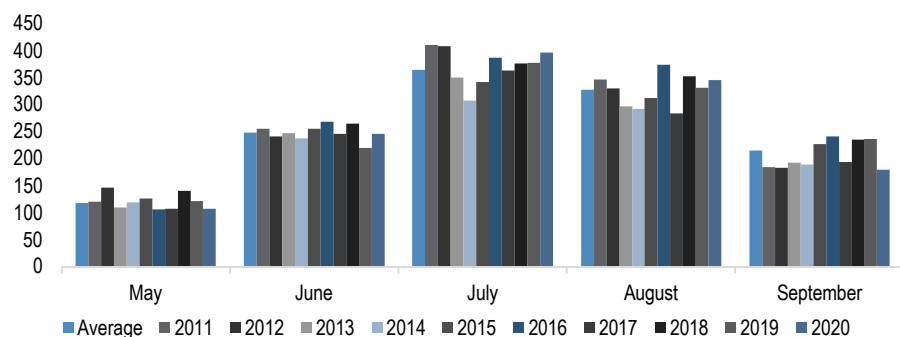
Weather: cool in 2013 and 2014, hot in 2015 and 2016, cooler in 2017, 2018 unusually hot, 2019 and 2020 above normal but down from 2018

Summer temperatures tend to be a significant driver of replacement demand in any given year. Note that after a cool 2009, cooling degree days in 2010 were among the highest in the last 30 years, with similar trends in 2011 and 2012; 2013, however, was slightly below average, and 2014 was a bit cooler than 2013. 2015 saw a rebound back to levels approaching 2010-12. 2016 was even hotter than 2015, while 2017 took a step back and was cooler. 2018 was an unusually hot season, ranked 4th hottest on records for the U.S. according to NOAA, while 2019 and 2020 heat was above normal but down from 2018.

Weather is an unpredictable variable, but a key to replacement demand.

Figure 375: Cooling Degree Days in Spring/Summer Months

Population Weighted



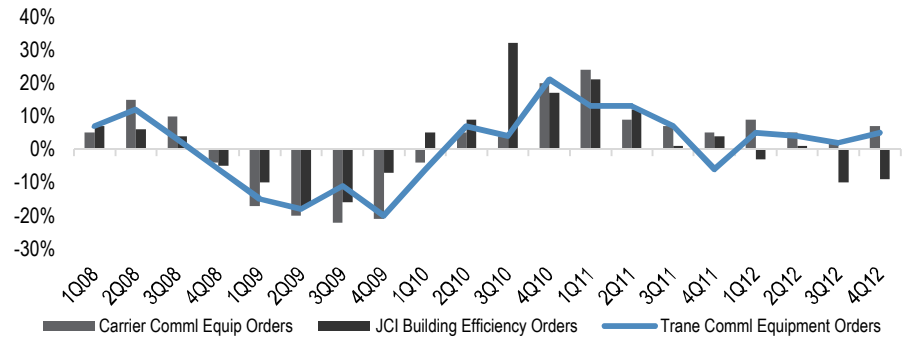
Source: NOAA

Commercial: Inflection in 2010-11, moderation in 2012, up in 2013-19 towards normalized levels, down in 2020 on COVID-19 impacts

Although trends in commercial unitary have broadly followed trends in the commercial construction market, their move off the bottom is actually more in line with the real-time leading indicators like the ABI, a dynamic that happened again this cycle. We would attribute this to the fact that replacement demand kicks in as the economy improves but before new construction, and that the smaller unitary equipment can be replaced sooner once business confidence returns. Keep in mind, however, that the heavy replacement component of commercial HVAC means that sales have inflected long before a turn in the construction environment. The charts below show how OEM orders and revenues inflected in 2010, the point at which non-res fundamentals stabilized and replacement deferrals ended, leading to double-digit growth for several quarters. In 2012-13, the pace of growth moderated, with drivers including (a) replacement activity that had returned to normalized levels, (b) limited follow-through from new construction, and (c) uncertainty in the economy that stalled some projects. 2014-16 saw another pickup, though not to the levels seen in the 2010 inflection. 2017 momentum was generally solid but not accelerating, while 2018 saw solid HSD growth, and 2019 was up in the LSD/MSD range. With COVID-19 hitting demand in 2020, orders/revs were down in the 5-10% range.

Figure 376: Commercial Orders 2010 Inflection

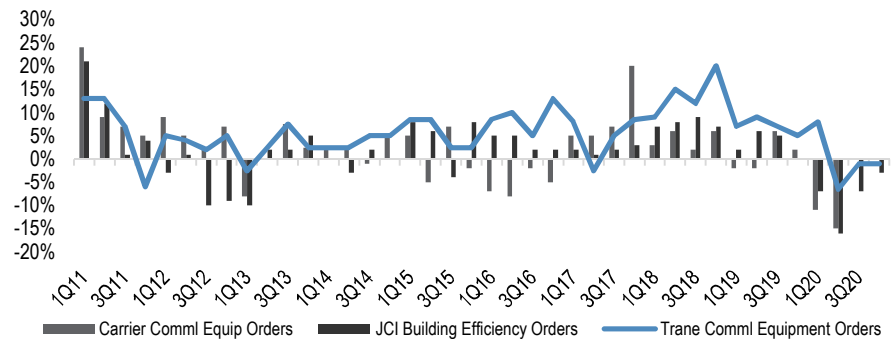
Y/Y change



Source: Company reports.

Figure 377: Commercial Orders Declining on COVID-19 Impacts

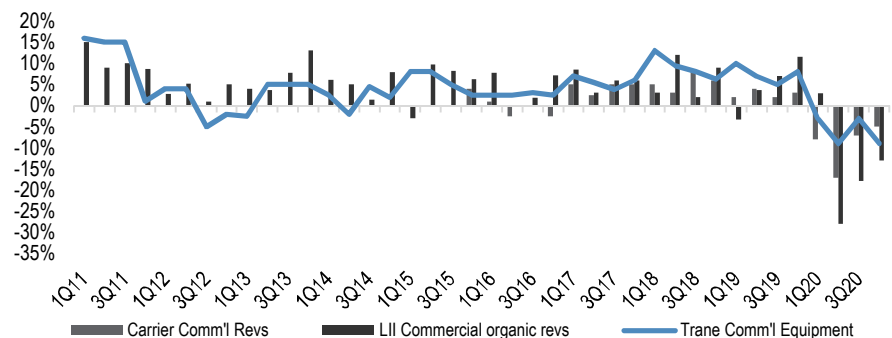
Y/Y change



Source: Company reports

Figure 378: Commercial Revenues Down due to COVID-19 Impacts

Y/Y Change



Source: Company reports

Appendix II: Tracking the Monthly Data

Quarterly growth rates for HVAC OEMs are notoriously difficult to forecast, but this section provides a framework on how to relate the available market data to company fundamentals.

This section provides a brief primer on interpreting the monthly data and relating it to the quarterly revenues of the major players. This is particularly important in times of volatility in industry data, helping better relate industry fundamentals to differences in OEM growth rates.

Two Major Monthly Data Sets: AHRI (“Sell In”) and HARDI (“Sell Through”)

There are two primary sets of HVAC data reported each month. The first is from AHRI, the organization representing OEMs, which tracks units shipped from the factory to distribution. The second is from HARDI, the independent distributors’ organization, which surveys members on the growth rate of total sales in a given month.

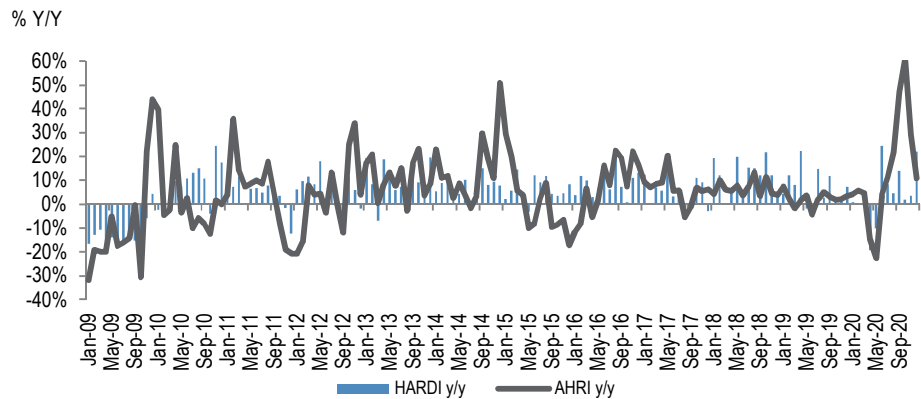
AHRI monthly shipments—Each month, the members of the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) each report the total number of factory shipments to distribution in a given month, giving a detailed and accurate view of substantially the entire US HVAC industry. The most followed data set is central air conditioners, though AHRI also reports shipments of heat pumps and warm air furnaces, both of which factor into OEM results. Remember that these data report units shipped *to distribution*, meaning that they will be more volatile when distributors are either building or taking down their inventories, such as during the recent 13 SEER pre-build.

HARDI distributor survey—Heating, Air Conditioning & Refrigeration Distributors International (HARDI) is the organization representing independent distribution in the North American HVACR industry. Each month its survey polls members on the growth in total dollar sales for their business, then reports the average growth of respondents. Unlike AHRI data, the HARDI survey does not provide a complete view of total industry unit shipments; however, it does provide a good directional indicator of underlying demand that is not influenced by inventory swings. This is because the survey tracks sales *from distribution end users* (i.e., contractors). Note that most HARDI members will also sell replacement parts, which can drive small differences in growth rates when the gap between equipment and parts/supplies is at extreme levels.

Wide differences between the two data sets are common . . .

In any given month, it is important to look at both data sets together to get a more complete picture of industry dynamics. Per the chart below, AHRI shipments can widely outperform HARDI sales in periods of inventory build and underperform in periods of destocking. This was particularly true in 2010, when distributors built inventories early in the season and then worked them down later in the summer, and 4Q14 as smaller OEMs shipped pre-built 13 SEER into the distribution channel. And this was again true in 3Q20 as distributors restocked following a stronger than expected summer selling season despite the impacts of COVID-19 on the economy.

Figure 379: Monthly AHRI A/C Shipments versus HARDI Median Distributor Sales



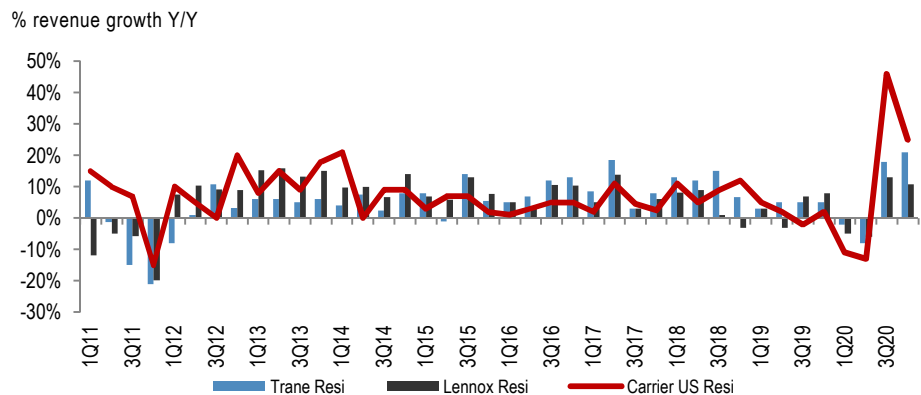
Source: AHRI, HARDI

... and OEM results can diverge as a result

Understanding distributor inventory dynamics is key to forecasting OEM revenues in any given quarter.

Similar volatility can be seen in quarterly results of the major resi OEMs, as seen in the chart below. With the exception of the R-22 dynamics in the summer of 2011, we generally do not view these quarterly fluctuations as representing share shift; rather, this is usually a function of the amount of company-owned versus independent distribution, and to a lesser extent the product mix (heating versus cooling). Below, we walk through the major publicly traded players and relate their sales to the monthly data.

Figure 380: Resi HVAC Growth Rates of Major OEMs



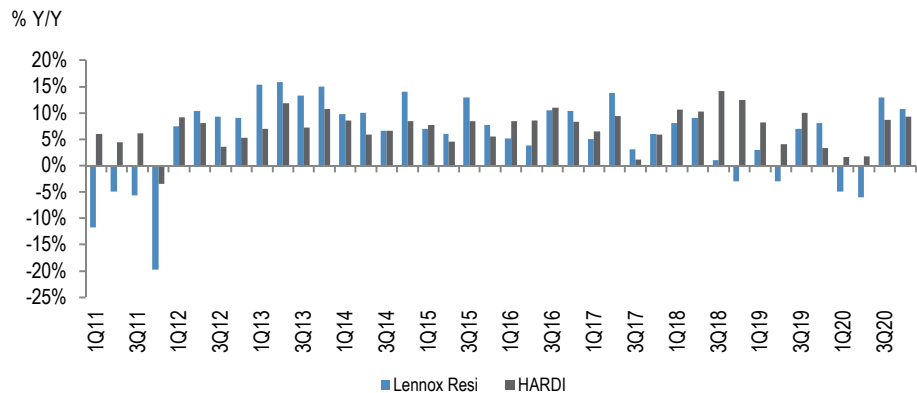
Source: Company reports

OEM-Specific Dynamics

LII: Big company-owned distribution means it tracks “sell through”

Lennox differs from other OEMs in that ~80% of its sales go through company-owned distribution, meaning its revenues should more closely track the HARDI statistics than the AHRI factory shipments. There is also a relatively larger weighting toward heating products, which are ~40% of resi sales. Indeed, over the last two years LII resi growth has closely tracked an index that is weighted more heavily toward the HARDI data and the AHRI furnace shipments for the winter months. The underperformance in 2011 (due to lower R-22 participation and the timing of price increases) was generally recouped in 2012, while the underperformance in 2H18/1H19 was driven by the tornado that impacted its Marshalltown plant capacity.

Figure 381: Lennox Resi HVAC Sales versus HARDI

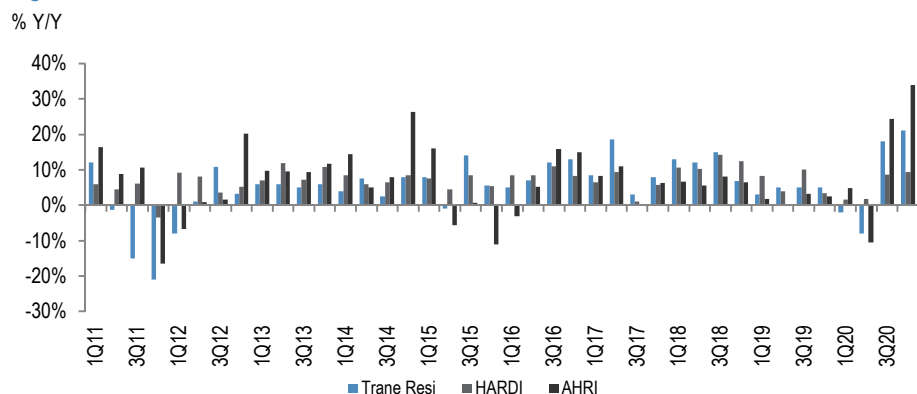


Source: Company reports, HARDI

IR/Trane: Roughly an equal split between “sell in” and “sell through”

The Trane residential business at IR is a split between “sell in” and “sell through” as the company owns ~50% of its distribution. Growth rates have been lumpier at Trane, with channel loading still having an impact, but directionally they track an index that represents this ~50/50 split. The 2011 underperformance, in our view, was largely attributable to the company’s limited participation in R-22.

Figure 382: Trane Resi HVAC Sales versus AHRI and HARDI

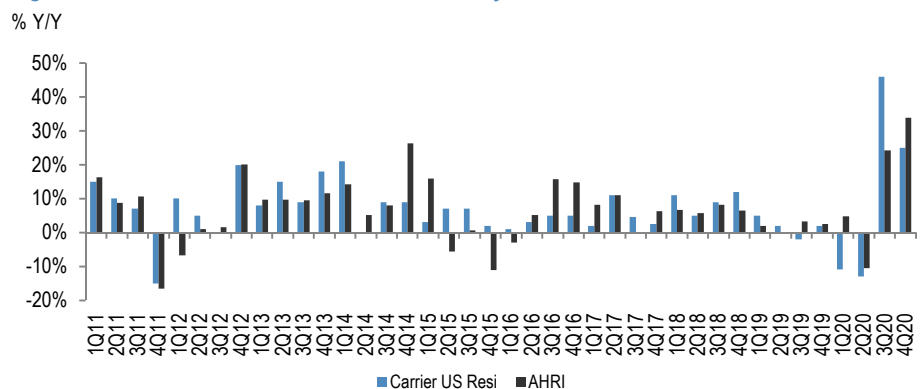


Source: Company reports, HARDI, AHRI.

Carrier: Good reflection of AHRI or “sell in”

Carrier sells primarily through third-party distribution and thus will most closely track the AHRI shipment data, outperforming when the channel is building inventories and underperforming as the industry de-stocks. Note that the chart below approximates Y/Y revenue growth based on management’s conference call commentary. We note that 4Q14 through 2015 is an exception here as smaller OEMs shipped 13 SEER into distribution, whereas Carrier held the inventory itself, causing the company to lag AHRI shipments during the pre-build period and come in ahead for the next two quarters.

Figure 383: Carrier Resi HVAC Sales versus Industry Index

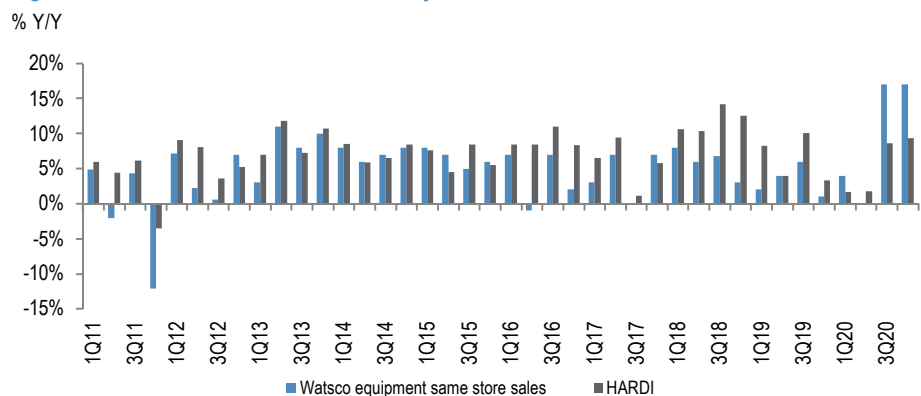


Source: Company reports, AHRI

WSO

Not surprisingly, WSO will most closely track the HARDI sell-through statistics as these data are essentially a poll of the smaller, independent competitors. The primary difference to keep in mind is around geography and mix, and WSO is weighted more heavily toward cooling products in the sun belt, with relatively less exposure to heating products in the northern US (though it is now relatively more diversified with the Carrier Enterprise JVs).

Figure 384: WSO Sales versus HARDI Survey Sales Growth



Source: Company reports, HARDI

Appendix III: Overview/Recent History of Regulatory Transitions

Here, we provide a brief summary of past efficiency regulations and their impact on the industry. We start with the new FER regulation that took effect in July 2019. We also review the most recent 14 SEER transition, which resulted in minimal disruption to the industry with an orderly transition. Then, we look back at prior transitions, where the impact was more dramatic, including the 13 SEER minimum efficiency standards, which took effect in December 2005, and the R-22 vs. R-410A refrigerant regulation dynamics, which played out over the course of 2010-2011. We think these transitions are instructive as case studies for the upcoming 14/15 SEER transitions, and provide some insight to the interplay between government and the HVAC industry as well as show how industry discipline/structure is critical to HVAC OEM success.

FER Regulation

The US Department of Energy (DOE) published a final rule (79 FR 38129) in July 3, 2014, prescribing new energy conservation standards for residential furnace fans, with HVAC manufacturers required to comply starting July 3, 2019. This regulation applied to the manufacture of standard units, such that companies were not allowed to manufacture those past July 3rd, though could continue to sell previously produced units that they had in inventory. The DOE expects the standard to save 3.99 quads of energy and reduce carbon pollution by 181mm metric tons by 2048, and to reduce carbon pollution by 34mm metric tons and produce >\$9B savings in home electricity bills through 2030.

Fan energy rating (FER) concerns energy consumption in heating, cooling and constant circulation, expressed in power consumption per delivered airflow (watts per 1,000cfm). The new FER standard specifies a minimum energy efficiency level, or maximum fan energy rating (FER) that varies based on the airflow provided by the furnace fan. While furnaces have historically been regulated by gas efficiency, the new standard will regulate electric efficiency, and will indirectly affect the type of technology/motors used in the furnaces, requiring new motors as ~80% of furnaces are equipped with standard induction motors. The industry sees a likely shift away from these lower-priced, standard motors (permanent split capacitor blower motors, or PSC), and towards electronically commutated motors (ECM), which are higher-priced, higher margins, and more energy efficient. The manufacturer Heil Heating and Cooling sees the new standards as implying a 46% watt reduction over a typical PSC furnace.

For background, there are three primary types of electric motors used in HVAC/refrigeration applications: shaded pole, PSC and ECM. As shown in the table below, the most efficient of the three is ECMs, for which there are three types: constant cfm (airflow), constant rpm (speed), and constant torque of the motor. ECMs combine electronic controls with brushless DC motors, such that they are able to maintain efficiency across a wide range of operating speeds. More specifically, they use a microprocessor controller that sequentially energizes/de-energizes each winding of the stator with power to generate an electrical current, using a closed loop feedback mechanism to more precisely control the magnetic fields, according to Building Energy Resilience. With a brushless motor, this reduces points of contact within the moving components of the motor. Additionally, these motors are programmable such that the motor will adjust to maintain the constant parameter (airflow/speed/torque), giving better controllability of the motor and increasing efficiency. The added technology in these programmable motors increases the cost of a furnace by ~\$25-50, according to Lennox.

Table 133: Types of Motors in HVAC/Refrigeration

Motors	Efficiency range
Shaded Pole (Induction)	15-20%
Permanent Split Capacitor (brushed DC)	30-50%
Electronically Commutated	60-75%+

Source: Building Energy Resilience (Cx Associates)

Table 134: ECM (Brushless) vs PSC (Brushed) Motor



Source: Building Energy Resilience (Cx Associates)

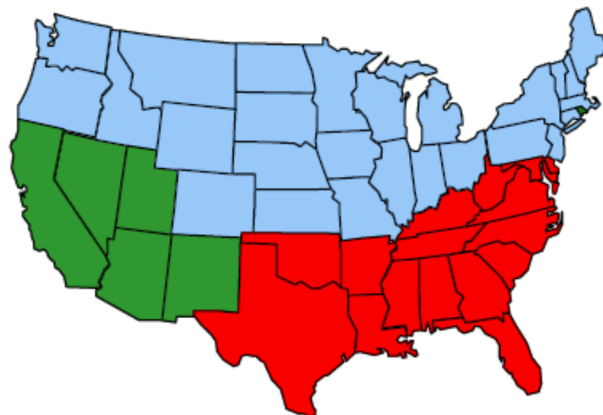
The net impact of the regulation depends on the balance between energy savings and higher upfront costs to manufacture. On one hand, given the higher priced new furnaces, homeowners may be incentivized to repair their existing units rather than replace them, which could impact equipment sales at HVAC systems providers. On the other hand, the DOE estimates savings for an average consumer of \$340-500 over the lifetime of a furnace fan, including the increased cost, and expects a cumulative NPV of total consumer costs and savings of \$10-29B (for a 3-7% discount rate) from 2019 to 2048.

A Look Back at the 14 SEER Transition

14 SEER transition summary

The HVAC industry underwent a regulatory transition to 14 SEER minimum efficiency at the end of 2015. We believe the transition was a slightly positive event for HVAC OEMs, in line with expectations. Here, we briefly recap the 14 SEER transition and discuss the implications of the transition on competitive dynamics and major players. The proposed regional standards divided the country into three regions: the Southeast, Southwest, and Northern markets. For furnaces (original target date of May 2013), the DOE was mandating a move to 90% AFUE for the Northern regions (those with >5,000 heating degree days), while the Southeast and Southwest would remain at 80% AFUE. For AC and heat pumps (target date of January 2015), it called for a 14-SEER minimum for the Southeast and Southwest markets. Unlike previous rules, which had prohibited the production of new units, the regional standards would be an installation ban under which it would be unlawful to install equipment that doesn't meet the minimum standards.

Figure 385: Regional Efficiency Standards Map (as Proposed)



Source: AHRI

Table 135: Minimum Federal Standards

As Initially Proposed (Intended to be effective Jan 1 2013 for Furnaces, Jan 1 2015 for A/C and Heat Pumps)

System Type	≥ 5000 HDD	< 5000 HDD	CA/AZ/NM/NV/UT
Split A/C	13 SEER	14 SEER	14 SEER /12.2 EER <45,000 Btu/h 14 SEER /11.7 EER ≥45,000 Btu/h
Split HP	14 SEER /8.2 HSPF	14 SEER /8.2 HSPF	14 SEER /8.2 HSPF
Package A/C	14 SEER	14 SEER	14 SEER/11.0 EER
Package HP	14 SEER/8.0 HSPF	14 SEER/8.0 HSPF	14 SEER/8.0 HSPF
Gas-Pack (weatherized)	14 SEER/81% AFUE	14 SEER/81% AFUE	14 SEER/81% AFUE
Gas Furnaces (non-weatherized)	90% AFUE	80% AFUE	80% AFUE
Oil Furnaces (non-weatherized)	83% AFUE	83% AFUE	83% AFUE

Source: AHRI

There were a number of legal challenges questioning the furnace rule, including a suit by the American Public Gas Association (APGA) in the United States Court of Appeals for the District of Columbia; this led to the delay of the furnace rule's original implementation. Subsequent to this, HARDI filed a motion to continue the lawsuit and address not only the heating standard but also the cooling standards transition previously scheduled for 2015. In early March 2014, all parties involved agreed on a settlement with the following parameters:

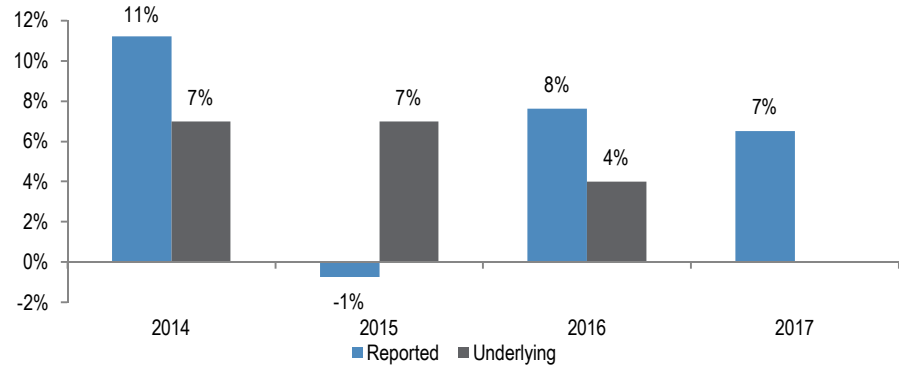
- The previously delayed furnace rule would be officially vacated and would require new rulemaking process likely not resolved until 2021-22 (at earliest).
- The 14-SEER cooling minimum in the South *would* be enacted January 2015, but the settlement added an 18-month "grace period" for distributors to sell 13-SEER equipment *manufactured before January 2015*.
- Distributors would not face any penalties under civil law for failure to comply with any of the regional standards.
- A committee would be formed to develop an enforcement plan with input from the various stakeholders, with the goal of a more detailed outline by July 2016.

The primary new development coming out of the settlement was the grace period and the incentive it created for a pre-build of 13-SEER equipment ahead of the 12/31/14 manufacturing deadline. This stood in contrast to the prior *installation-only* ban that applied irrespective of the manufacturing date and therefore created no incentive to pre-build. Also keep in mind that 13-SEER represented ~75% of the overall market headed into the transition, with close to 75% of AC/heat pump demand coming from the affected Southern regions, a material degree of pre-build. Ultimately we think ~1.1mm units were pre-built with 285K of these shipped into distribution.

We estimate 1.1mm units were pre-built, and ~285K units were pulled into 2014 distribution channel as pre-buy

The AHRI shipment results from the last few months of 2014 clearly reflected the impact of 13 SEER pre-buy on the channel. While most major OEMs opted to pre-build 13 SEER and hold the inventory, we estimate that ~285K units were shipped into the distribution channel between September and December, based on an assumption of ~6% underlying growth rate in shipments. Based on industry commentary and OEM inventory builds, we estimate total 13 SEER pre-build at ~1.1mm, meaning ~30% of the pre-built volume was shipped into distribution as pre-buy. These 285K units were pulled into 2014 at the expense of 2015, thus impacting the resulting AHRI y/y growth rates for 2014-16, as shown below. Backing out the impact of pre-buy, we see that "underlying" industry growth was relatively steady at mid to HSD levels, while reported AHRI growth was more volatile due to the impact of pre-buy.

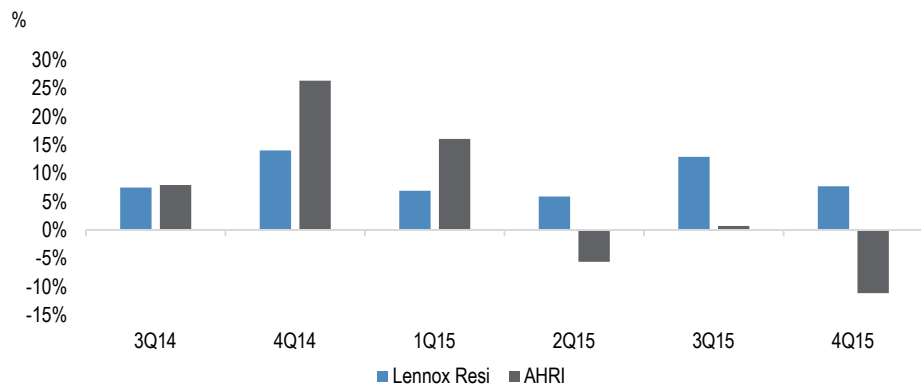
Figure 386: AHRI Reported vs. Underlying (ex pre-buy) Volume Growth Estimates



Source: J.P. Morgan estimates.

Putting the AHRI data together with reports from OEMs, there was an interesting bifurcation between larger and smaller players, as smaller HVAC OEMs disproportionately shipped their 13 SEER products into distribution as pre-buy, while larger OEMs were able to hold the 13 SEER as inventory and ship into distribution as needed during the 2015 selling season. Indeed, we saw little evidence of a pre-buy effect at Goodman, Carrier, Trane, and Lennox, each of which reported solid MSD to HSD growth in 4Q14, in line or slightly above what we estimate as underlying industry growth, with inventory build suggesting more “pre-build” here. While most of the smaller players are private, making specific data difficult to obtain, it stands to reason that with industry shipments up ~20% from September to December and each of the major players reporting MSD to HSD growth rates, the majority of the 13 SEER pre-buy impact came from smaller players. Similarly, most of these major OEMs reported MSD volume growth throughout 2015, including 4Q15, even as reported AHRI shipments declined double digits in 4Q15.

Figure 325: Lennox Resi Organic vs AHRI Shipments

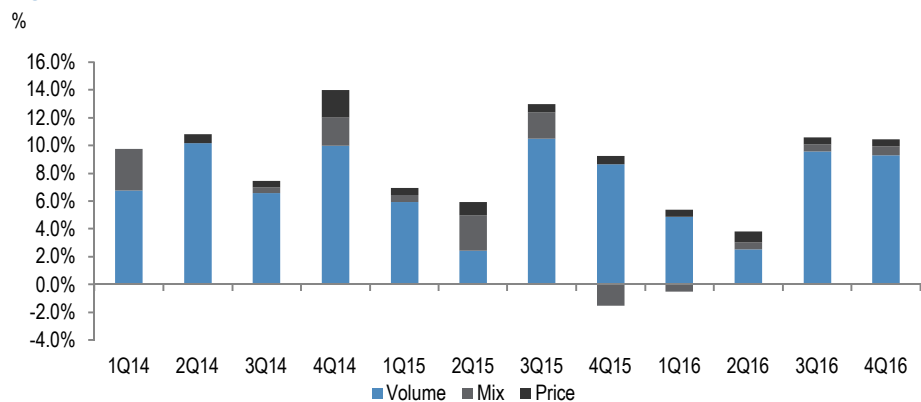


Source: Company reports and AHRI

Price/mix: revenues outpaced volume growth in 2015/16, with boost from 14 SEER

14 SEER stood at a ~15% price premium to 13 SEER entering 2015, with our channel checks and survey work indicating that this premium compressed slightly over the year to 10-12%, in line with our expectations. As 14 SEER made up more of the market in 2015, this higher price created a tailwind for OEMs, and revenue growth outpaced volume growth with most reporting solid price/mix gains. This price premium compressed to HSD to 10% levels throughout 2016, still a tailwind but not at the same levels as 2015. We note that these positive price/mix tailwinds are a material change versus the prior transition in which major value players were reportedly priced ~20% below prevailing industry rates, onto which the high end collapsed.

Figure 387: Lennox Volume vs. Mix vs. Price



Source: Company reports

Margins: likely also benefitted in 2015/16 as 14 SEER price premium outpaced cost differential

The mix dynamic discussed above likely also helped gross margins in 2015/16, as the 10-15% price premium for 14 SEER over 13 SEER exceeded the cost differential, which we estimate at closer to ~5% as many of the critical parts (such as the compressor) are the same for both 13 and 14 SEER. The main cost difference is that 14 SEER units use more raw materials like steel, less of a needle mover given low commodity prices throughout the transition. Our detailed illustrative margin analysis that incorporates the upside price from 14 SEER, along with the more limited cost increase, gets us to a gross margin that is around 410bps higher in 14 vs. 13 SEER.

Key differences from past transitions, generally negative experiences for OEMs

A similar transition from 10 to 13 SEER took place in 2005-06 (see next Appendix section) but was quite different in its limitations and scope. First, it was a selling ban on units that at that stage represented ~90% of the industry, which led to a substantial 10 SEER “pre-buy” rather than the recent manufacturing ban, which resulted in more of a “pre-build.” Additionally, last transition, given the magnitude of the system price premium, value players were positioned well below competitors, and the structure of the industry was more bifurcated. This time, the jump from 13 to 14 required only ~5% more cost on the components and materials side versus the ~30% seen from 10-13. There was also a significant difference in the macro backdrop with solid US consumer fundamentals versus 2006 and 2010 (positive) and more stable commodity inflation (more of a risk around price discipline).

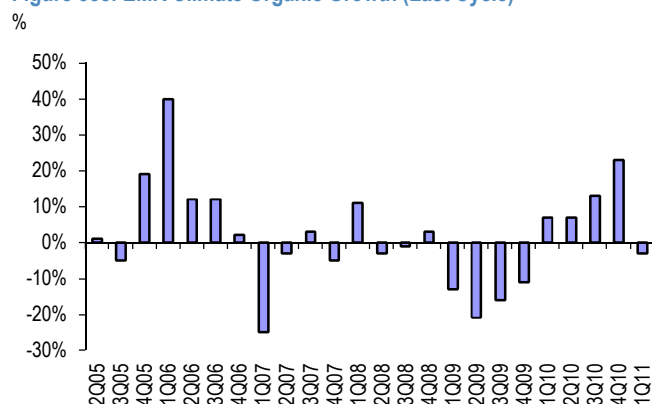
OEM differentials: industry structure led to smoother transition

On AHRI, the large, public OEMs mainly held pre-built 13 SEER as inventory without shipping into distribution, as demonstrated by their growth rates lagging AHRI in 4Q14, which reflected independent's pre-buys mostly coming from smaller OEMs; this reversed in 2015. On share and margins, it's well accepted that the premium brands like Trane lost in the prior transition as the more profitable higher end was commoditized, and Goodman won, with share going from "high teens" to ~25%. However, a look at the industry structure this time around showed Trane established at the low end, and with Goodman actually looking to go up market to a degree and with less of an aggressive price differential, we think the sand box here was more collegial with little disruption. Both Lennox and Trane outperformed AHRI on volumes in 2015, after lagging in 4Q14. Both companies saw solid margin expansion partially driven by mix over the ensuing several years.

Emerson a bit of an outlier

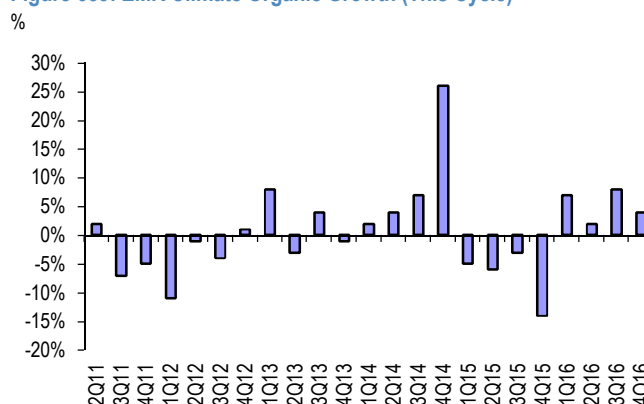
Along with Goodman, Emerson was a big winner in the 2005/06 event as scroll penetration grew dramatically, a benefit of 2-4% to segment growth, along with price that contributed 2-3%. This time around, while OEMs were smoothed out by the pre-build/pre-buy dynamic, Copeland was shipping compressors for the entire 1.1mm units in 2015 leading to a big FY1Q Dec-end, with a drop-off over the next four quarters. Through the transition, we didn't see price benefits or share gains given saturated penetration and the stable cost of 14 vs. 13 SEER compressor.

Figure 388: EMR Climate Organic Growth (Last Cycle)



Source: Company reports

Figure 389: EMR Climate Organic Growth (This Cycle)



Source: Company reports and J.P. Morgan estimates

Revenue: mix up helped by 1-2%

14 SEER pricing was resilient throughout 2015, showing only slight degradation to 10-12% from ~15% prior, and 2016 held up solidly in the 8-10% range. We do not see a scenario where 14 SEER price drops to where 13 SEER stood prior to the transition, which was the case during the 10 to 13 SEER transition in 2006. In other words, the new entry level price for HVAC equipment was higher going forward.

Table 136: 14 SEER vs. 13 SEER pricing gap

%		
Prior to Transition	2015 Estimated	2016 Estimated
~15%	10-12%	8-10%

Source: Company reports and J.P. Morgan estimates

We estimate that industry revenues grew 11% in 2014 (8% ex pre-buy), 3% in 2015 (8% ex pre-buy), and 9% in 2016 (5% ex pre-buy). We estimate that mix contributed 1% in 2014, 2.6% in 2015, and ~2% in 2016. The primary driver of this mix tailwind was from the SEER mix shift depicted above as 13 SEER exited the market and 14 SEER became the new minimum efficiency.

Table 137: Industry unit shipments analysis

	2013	2014	2015	2016
AHRI Units				
Total AHRI units	5,921	6,586	6,538	7,037
% growth		11%	-1%	8%
13 SEER	4,322	4,478	2,697	1,618
14 SEER	651	922	2,419	3,659
15 SEER+	947	1,185	1,422	1,759
Industry SEER Mix				
13 SEER (ex prebuy)	73%	68%	41%	23%
14 SEER	11%	14%	37%	52%
15 SEER+	16%	18%	22%	25%

Source: AHRI and J.P. Morgan estimates

Margins: transition a modest positive as price premium held and cost profile was similar between 13 and 14 SEER

From a cost perspective, our channel checks suggest main components like compressors and motors, representing 50-60% of the unit cost, remained the same between 13 and 14 SEER, with material the largest variable cost within the system. Given that the cost basis between 13 and 14 SEER is roughly the same while pricing was ~10% higher for 14 SEER, the high-level, illustrative math shows that gross margin, all else equal, was about 410 bps higher on current 14 SEER units, helping drive solid margin improvement through the transition. This analysis assumes that 14 SEER product cost comes down ~2% each year on general productivity efficiencies.

Table 138: Gross margin analysis

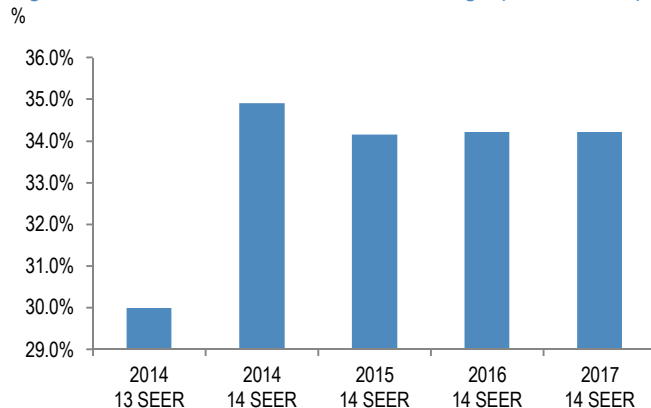
	13 SEER	14 SEER 2014E	14 SEER 2015E	14 SEER 2016E
Assumed 14 SEER Premium	0%	15%	11%	9%
Price (Indexed)	1,000	1,150	1,110	1,090
Costs				
Compressor	350	350	343	336
Motors	70	77	75	72
Refrigerant	42	42	42	42
Materials	175	206	199	193
Coils/other	63	74	72	70
	700	749	731	714
Gross Margin	30.0%	34.9%	34.1%	34.5%

Source: Company data and J.P. Morgan estimates

A key topic of debate heading into the 14 SEER transition was the ability of OEMs to sustain premium pricing on 14 SEER products. During the 13 SEER transition in 2006, a pricing gap of ~75% between 10 and 13 SEER products quickly narrowed to ~30% before ultimately normalizing further as 13 SEER became the low end of the market and a new “battleground” for pricing was established as value players gained share at the expense of premium players in this market. The 14 SEER pricing premium moderated slightly as 13 SEER product was phased out of the market, but it

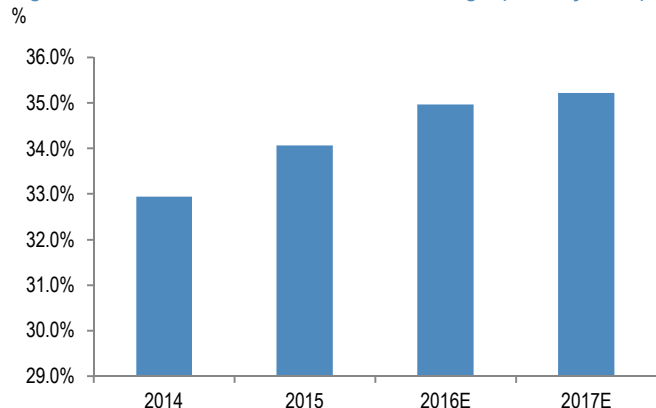
remained an orderly transition where the normalized entry level for 14 SEER still ended up at a premium to the prior entry level price of 13 SEER. We think this premium finished 2016 at around 8-10%, where it likely stayed into 2017. Ultimately, on a 14 SEER product level, we saw an initial margin bump from 13 to 14 SEER in 2015, with 14 SEER margins normalizing moving forward as costs come down roughly in line with gradual price premium erosion. Industry gross profit margins steadily increased in both 2016 and 2017 as 13 SEER product disappeared and is replaced by higher margin 14 SEER.

Figure 390: 13 vs 14 SEER Illustrative Gross Margin (Product Level)



Source: J.P. Morgan estimates (illustrative example)

Figure 391: 13 vs 14 SEER Illustrative Gross Margin (Industry Level)



Source: J.P. Morgan estimates (illustrative example)

Customers still gravitating toward the value segment

Most customers have traditionally opted to purchase lower efficiency units rather than pay a higher upfront cost to achieve energy savings with premium products. We do not expect this consumer behavior to change much, but we do note that a ~10% price premium for 14 SEER is small in the context of the overall cost of an HVAC system, and consumers are unlikely to provide significant resistance to a 14 SEER unit, partially due to the pricing power discussed above. We surveyed a group of independent distributors in October 2014 regarding their expectations for the transition, and the results indicated that these distributors expected customers to continue to gravitate toward the value segment.

Table 139: How will customer behavior be impacted by the upcoming 14 SEER minimum efficiency standard?

13 to 14 SEER price difference	Number of responses	Response ratio
Customers will more likely move up to higher SEER units	10	12.7%
Customers will gravitate towards the lowest cost products	38	48.1%
Customers more likely to repair given cost of 14 SEER and higher	10	12.7%
No significant change in behavior	21	26.6%

Source: JPM/HARDI survey (October 2014)

Table 140: Selected survey comments

How will customer behavior be impacted by the upcoming 14 SEER minimum efficiency standard?

"With the minimal cost difference in current 13 to new 14, customers will still buy mostly 14 once the 13 inventory is depleted"

"As with previous efficiency changes, the low-end customer will move to the lowest possible offering and the 14 SEER customer will stay put, compressing all usage in both 13 and 14 SEER into one efficiency. It will be a slow but steady move off of the entry level over the next year or two."

"Repair vs. replace is driven more by consumer confidence than SEER or price"

"If the gap between 14 SEER and 13 SEER ends up at 10% or less, then it will be more difficult for distribution to move the 13 SEER inventory"

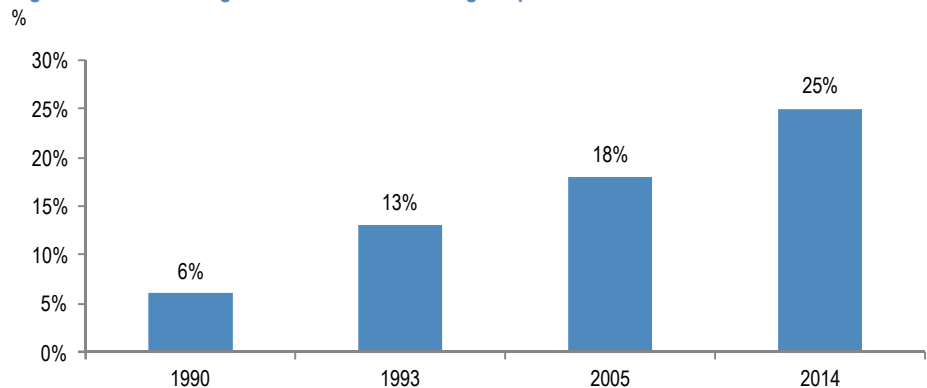
"At a consumer level, it isn't that much difference in the total cost of the installation"

Source: JPM/HARDI survey (October 2014)

Market Share: no major moves

Prior regulatory transitions have had a clear impact on OEM results and created clearly discernible winners and losers. In particular, the 2005-06 changeover saw premium players lose significant share to value players such as Goodman, which had a much lower cost base. The competitive landscape was different this time around, however, as Goodman became more saturated and premium players have evolved their business model to now have less to lose if the market shifts drastically toward low-end efficiency units again.

Figure 392: Goodman gained market share during the past two minimum SEER transitions



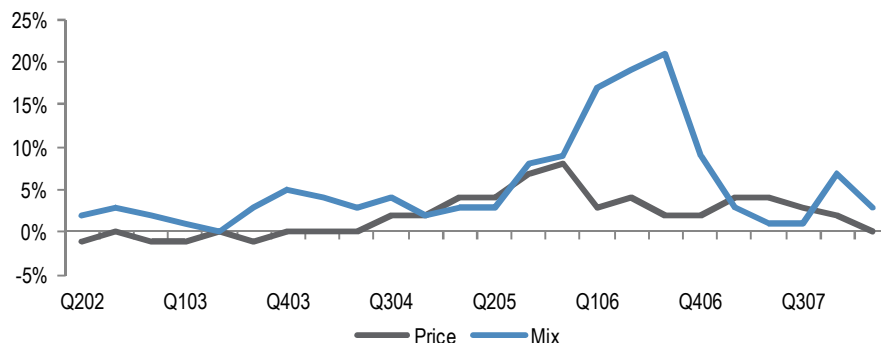
Source: AHRI and company reports

Trane has diversified into the value segment

Although Trane no longer reports specific volume/price/mix percentages, the company does comment on general mix trends, and summarizing this commentary illustrates the company's shift in focus in the 2011 timeframe as it lost share when low efficiency units grew at a much faster pace than premium units. This led to a steady decline in mix over a period of two to three years as Trane introduced new, lower-margin products for the value segment. When we examine the table and chart below, we see that Trane realized solid mix benefit for an extended period as it focused on the high end of the market and then saw a steady erosion in mix as it diversified its offerings in the low end.

Figure 393: Trane mix was solid when focused solely on high end products . . .

Trane price/mix dynamics from 2002-2007



Source: Company reports

Table 141: . . . and mix continued to be a positive driver as it maintained this high end focus . . .

Quarter	Commentary
Q208	"Volume declined mid teens, price was essentially flat, and improved mix contributed mid-single digit sales growth as we continued to significantly outpace the industry on sales of high efficiency systems."
Q209	"Improved mix partially offset lower volumes."
Q309	"Improved mix partially offset lower volumes."
Q409	"Higher mix as we did not participate in the R-22 system load in."
Q110	"Higher mix"
Q310	"The mix is moving towards 15 SEER and that's the sweet spot for us, 15 SEER and above. We've been systemically refreshing up from starting with 13 SEER, up through 14..."
Q410	"The mix is good. We did plan a mix shift down. Surprisingly, it's a little stronger perhaps than what we were thinking in terms of the efficiency mix."

Source: Company reports

Table 142: . . . but mix turned negative as Trane diversified to the value segment

Quarter	Commentary
Q111	"Operating margins were down as volume and pricing were more than offset by product launches, mix, and inflation."
Q211	On deciding to participate more aggressively in R-22 dry shipments: "At the end of the day, if it's a million unit plus market, and [the loophole] is not going to close, and we've got dealers that are disadvantaged from this, we are going to have to readdress it. We're not going to put our dealers at a disadvantage and we are not going to cheat our shareholders on our fair share."
Q311	"The impact on our business was further exacerbated by the continued downward mix shift by consumers to lower SEER, lower cost, less-featured systems. Our Trane business model has traditionally been built around providing premium products, customer support and efficiency levels. We believe this a medium to long-term shift in consumer behavior and are making the necessary adjustments to adapt our products and business model to this trend."
Q411	"Volume, mix, and foreign exchange were a 1.6% headwind to margins. This was mainly attributable to lower margin residential HVAC mix."
Q112	"Negative mix"
Q212	"Mix continues to shift to the low end of the range, validating our strategy to have products to address that SEER range more effectively."
Q312	"Mix continues to shift to the low end of the efficiency range. This further validates our strategy to add products to address the lower SEER range more effectively. Our market share in 13/14 SEER has now recovered."
Q412	"The 13 to 14 SEER share of the market was higher than the prior year, as mix shifted to the low end of the efficiency range."
Q113	"Adverse mix"
Q213	"Adverse mix"
Q313	"Adverse mix"

Source: Company reports

Survey results show a wide range of anticipated “winners” from the transition

We also surveyed our group of 82 independent contractors in October 2014 to get their take on which HVAC players they anticipated would be the “winners” of the 14 SEER transition. We allowed our respondents to choose multiple brands in their response if they felt several companies were well positioned. While value players like Goodman still received the most votes, we note the wide range of responses among those surveyed as 6 out of the 11 OEMs we listed on the survey received a vote on over 19% of responses. Lennox and Trane each received votes on ~20% of the responses. We believe these results support our assertion that industry structure was different this time around, and both premium and value brands were positioned to succeed.

Table 143: Which brand(s) do you believe are best positioned to be “winners” in the upcoming 14 SEER minimum efficiency transition?

Brand	Number of responses	Response ratio
Carrier	30	38.9%
Daikin	21	27.2%
Goodman	43	55.8%
Hitachi	2	2.5%
Lennox	15	19.4%
LG	2	2.5%
Mitsubishi	7	9.0%
Nortek	8	10.3%
Rheem	17	22.0%
Trane	16	20.7%
York	9	11.6%
Other	12	15.5%

Source: JPM/HARDI survey (October 2014)

Table 144: Selected survey comments

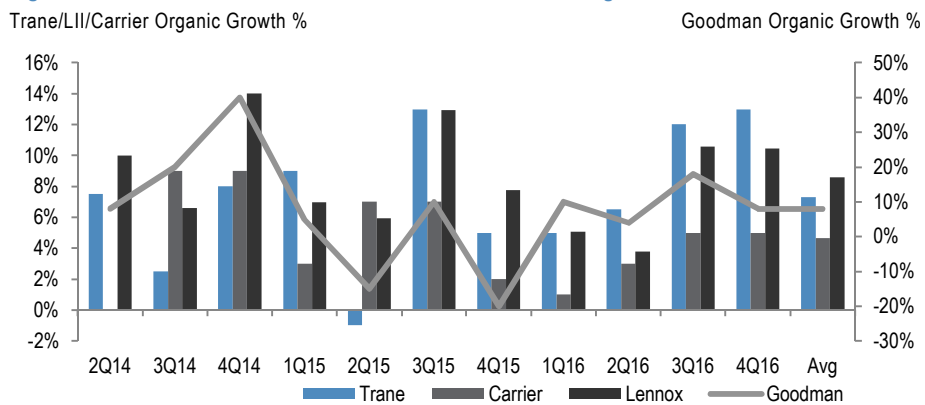
Which brand(s) do you believe are best positioned to be “winners” in the upcoming 14 SEER minimum efficiency transition?

“Tough to answer without researching every line. The EER requirement in the Southwest region is throwing everyone for a loop”
“I think everyone will be in the game. Everybody understands the entry level market now and knows they need to compete at that level.”
“Brands that have an optimized 14 SEER platform ready to sell early in 2015 will have an advantage.”
“Don’t see any clear winner”
“The first one to be able to profitably move a 14 SEER at a 13 SEER price will be the initial winner.”

Source: JPM/HARDI survey (October 2014)

Supporting our conclusion that there were no major market share shifts as a result of the transition, we show below the quarterly organic growth rates for the major OEMs. Other than some inventory swings at Goodman which then normalized, growth rates were consistent among OEMs in the MSD type range, with Lennox and Trane picking up some share at the expense of Carrier, in our view.

Figure 394: Residential HVAC OEM Growth Rates Similar Through Transition



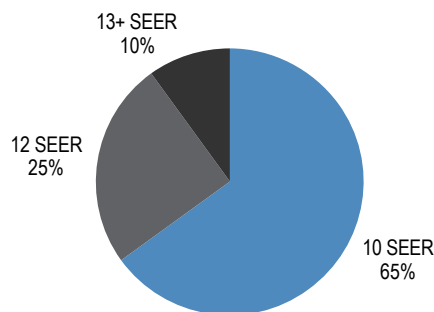
Source: Company reports (Note: Goodman on secondary axis due to large inventory swings, but overall growth in line)

A look back at 10-13 SEER transition

The 10-13 SEER transition was a dramatic shift and applied to 90% of the industry, with, at the time a ~75% increase in price between the standing low end and the new low end, before quickly correcting to ~30% and moderating further toward 10 SEER. The changeover also skipped over a significant portion of industry volume, which was at 12 SEER; in other words, what had been 11% of the industry became 80% of the industry. Because this was a “shipping” ban, there was significant pre-buy, and volumes went down the following year because of that, as well as a tougher housing economy. However, mix was a dramatic positive, driving revenue growth and margins for the major players in the years immediately following. However, competitively, the leading value brand that had a stripped down low-cost position gained dramatic market share at the expense of the high end brands, which also saw longer-term margin compression as the higher margin products were cannibalized. We walk through the experience in more detail below.

Figure 395: 2005 industry mix

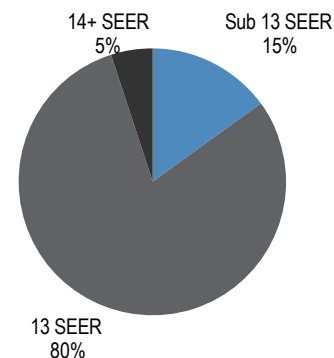
%



Source: Company reports and AHRI data

Figure 396: 2006 industry mix

%



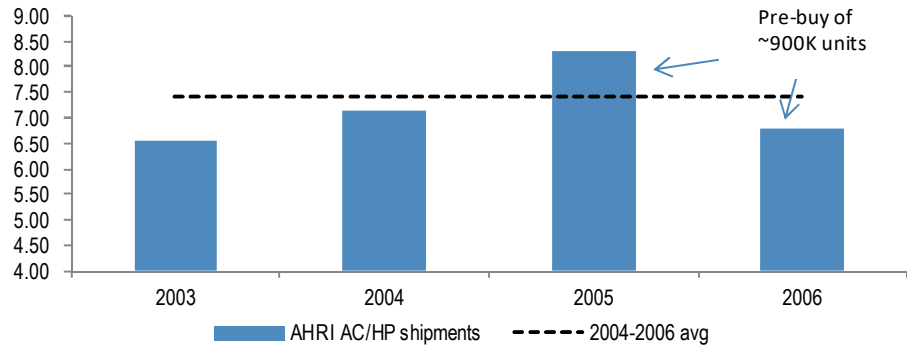
Source: Company reports and AHRI data

Significant 10-SEER pre-buy took place in 2005 . . .

The transition to a 13-SEER minimum implemented a selling ban on 10 SEER products beginning in 2006. Manufacturers had to sell in to distributors prior to year-end, which caused a pull-forward of 10-SEER product into the channel prior to the transition taking effect on December 31, 2005. Smoothing out demand on a three-year basis, we estimate ~900,000 units were pulled forward, or approximately 12% of annual industry demand. As a result AHRI shipments increased 17% in 2005 and then fell 19% in 2006. The 10 SEER selling ban contrasts to the 13 SEER manufacturing ban in that OEMs were allowed to manufacture 13 SEER in 4Q of 2014 but did not have to sell in to distributors before year-end. Instead, they could hold 13 SEER inventory themselves for distributors to pull on an as-needed basis. Thus, the recent transition was more of a “pre-build” than a “pre-buy.”

Figure 397: The 10 SEER Pre-Buy in 2005 Was Somewhere Around 900,000 Units

AHRI shipments, millions of units

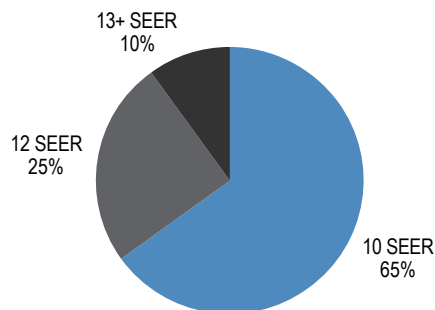


Source: AHRI, J.P. Morgan

... and mix offset volume declines in 2006

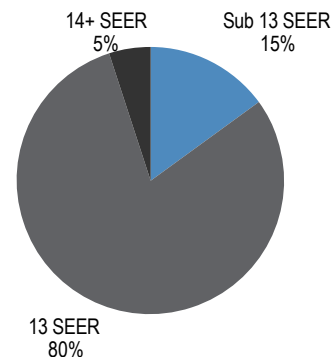
Interestingly, despite the decline in volume, OEM revenues still grew ~11% in 2006 as the positive mix as well as commodity-related price increases helped offset the volume declines. This shift was dramatic as the industry moved from 65% 10 SEER, 25% 12 SEER (which had been the preferred industry level) and only 10% 13+ SEER to ~80% 13 SEER.

Figure 398: 2005 industry mix
%



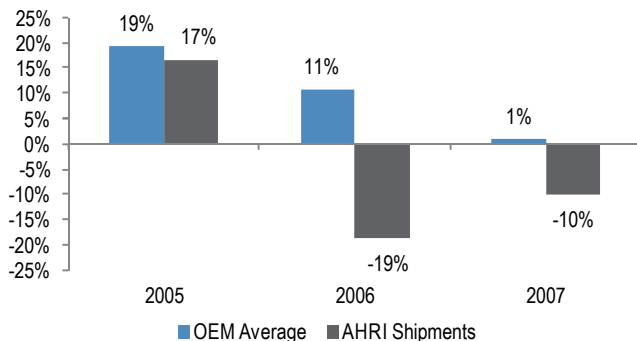
Source: Company reports and AHRI data

Figure 399: 2006 industry mix
%



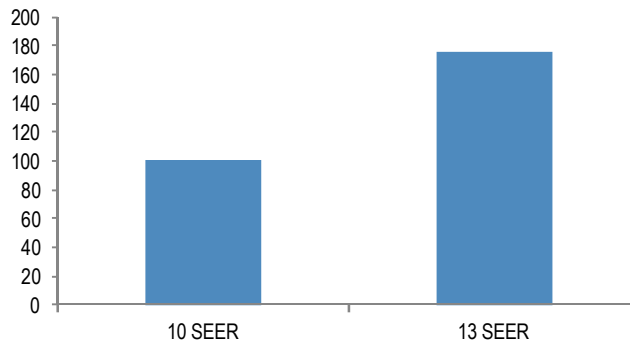
Source: Company reports and AHRI data

Figure 400: OEM revenues outpaced volume declines...
%



Source: AHRI and company reports

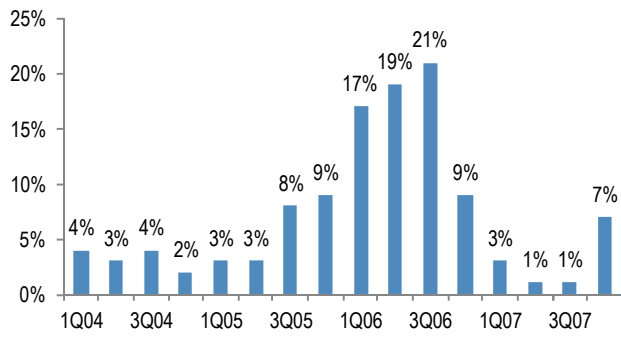
Figure 401: ...as 13 SEER was ~75% higher cost
Indexed cost (10 SEER R-22 = 100), ignoring inflation



Source: J.P. Morgan estimates

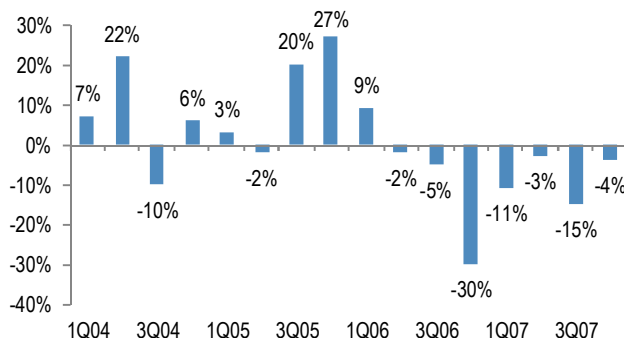
While not all OEMs quantify these moving parts, Trane reported volumes and mix impact throughout the transition, and we can examine these numbers as a case study for other industry players. Consistent with our industry-wide analysis and high-level company-specific metrics, Trane experienced a decline in volumes that was offset by a positive mix impact from higher priced 13 SEER products.

Figure 402: Trane saw a positive mix impact...
Y/Y% change, Trane Residential mix benefit



Source: Company reports

Figure 403: ...offsetting volume related declines
Y/Y % change, Trane Residential volume benefit



Source: Company reports

It is difficult to bridge the revenue increase from 2005-06 on an industry-wide basis exactly, but the disclosures and market commentary of the OEMs at the time give us a rough picture. First, on unit volumes, OEMs like Goodman/Trane/Lennox own significant portions of their own distribution channel, meaning the unit sales that show up in recorded revenue will be less than the AHRI factory shipments (which only reflect "sell in"). Additionally, 2005-06 were strong years for price increases in response to raw material increases. Lastly, mix was favorable both in 2005 (when some customers began shifting up to higher SEER) and particularly in 2006 (when the mandate kicked in). A rough rule of thumb suggests a 7-8% increase in unit cost per SEER level.

Table 145: Approximate View of Resi OEM Revenue Drivers

% Y/Y revenue impact		
	2005	2006
Price	7%	3%
Mix	6%	26%
Units	12%	-13%
AC/HP total	25%	16%
Furnaces	0%	-9%
Components/other	10%	10%
AC contribution	18%	11%
Furnace contribution	0%	-2%
Components contribution	1%	1%
Other factors	1%	1%
Reported revenue growth	20%	12%

Source: Company data, J.P. Morgan estimates

Margins were solid in years immediately following transition

Our analysis also shows that OEM players not only saw nice revenue growth on mix, but margins also went up as the high profitability of the higher efficiency units were maintained for a period of time. In other words, while there were higher cost components, the difference was not enough to offset the ~75% increase in the equipment price, which quickly normalized to ~30% before normalizing further toward previous 10 SEER pricing. OEM margin growth would have been even more impressive if not for company-specific issues at Lennox during 2006-07, causing Lennox to be the only OEM to see margins decline over this period. Residential profits were negatively impacted as the business experienced component availability issues and operating inefficiencies resulting from the relocation of production from Ohio to South Carolina as part of restructuring. Lennox also adjusted its warranty reserve in 2006 and took a higher warranty expense, dragging on profits. If we exclude Lennox from the table above, the OEM average margin improvement from 2005 to 2007 for Carrier, Goodman, and Trane would have been 190bps, almost double the 100bp improvement when including Lennox.

Table 146: OEM revenues and margins benefited from 13 SEER transition

%	2005	2006	2007
AHRI Shipments y/y %	17%	-19%	-10%
Carrier			
Sales Growth y/y %	17%	8%	9%
Operating Margin %	8.8%	9.2%	9.4%
Goodman			
Sales Growth y/y %	19%	15%	8%
Operating Margin %	9.7%	11.9%	13.6%
Lennox			
Sales Growth y/y %	20%	10%	-10%
Operating Margin %	12.1%	11.4%	10.4%
Trane			
Sales Growth y/y %	22%	11%	-3%
Operating Margin %	8.6%	9.6%	9.6%
OEM Average			
Sales Growth y/y %	20%	12%	1%
Operating Margin %	9.8%	10.5%	10.8%

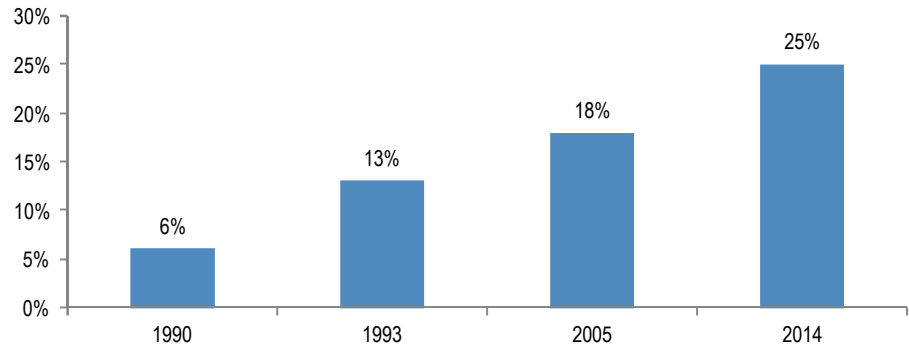
Source: Company reports, AHRI, J.P. Morgan estimates

Note: Carrier and Goodman sales growth is total company sales. Lennox and Trane sales growth is just residential. Lennox and Trane operating margins are residential, and Carrier/Goodman operating margins are total company operating margin.

Major winners and losers: market share swing to Goodman, dramatic benefits for Emerson

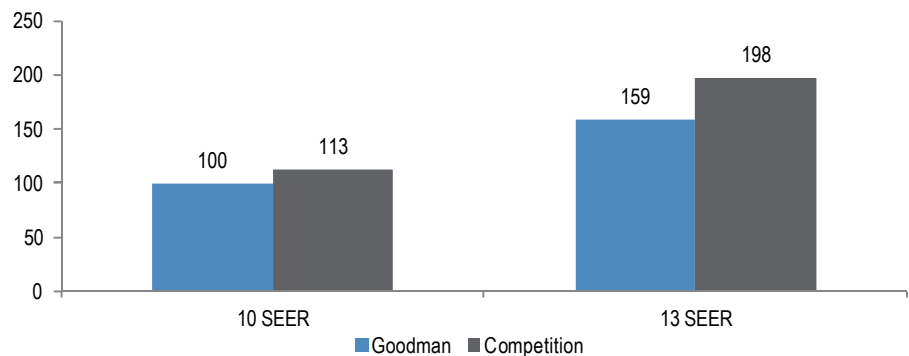
Another key dynamic was a shift in market share as the key value brand, Goodman, positioned itself with a unique low-priced option, and it maintained its stronghold on the lower end of the market, which expanded with the transition. Goodman was the only major OEM to support the move to 13 SEER, while others were concerned that margins on their premium 12-13 SEER products would be compressed as the market shifted to a 13 SEER minimum. In our view, many of the high-end OEMs with greater than average levels of high SEER product used the profit benefits of an up-sell on efficiency to subsidize the low-end brands. Following the transition, those OEMs were forced to up-sell the consumer to 14-16 SEER products, which were considerably more expensive and difficult to sell. We estimate Goodman took market share in the years surrounding the 13 SEER transition, moving from an estimated 19% at the time of the change to the standing ~25%. This is similar to what happened in 1990 with the move from 8.5 SEER to 10 SEER, which drove Goodman from 6% to 13%. Pricing on 10 SEER units moved down to the 8 SEER price fairly quickly after the transition occurred as the change to a 10 SEER merely required a \$10 compressor change-out. The 13 SEER transition experienced a much sharper increase in price points given the units required an estimated 45% more heat exchanger surface, a new compressor, different types of valves (expansion versus thermal) and a larger cabinet. At the time, Goodman touted its cost advantage on 13 SEER, which it believed at the time was ~20% below competitors, which faced a ~75% increase.

Figure 404: Value brand has gained market share during the past two minimum SEER transitions
%



Source: AHRI and J.P. Morgan estimates

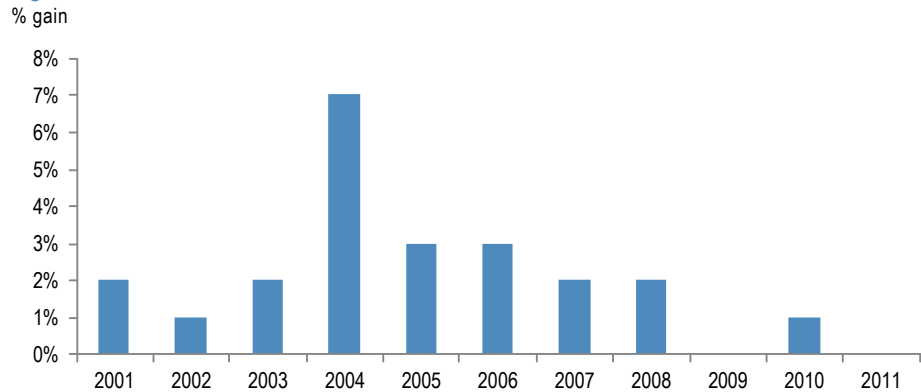
Figure 405: Goodman cost advantage during 13 SEER transition (indexed)
Indexed to Goodman 10 SEER cost



Source: AHRI and company reports

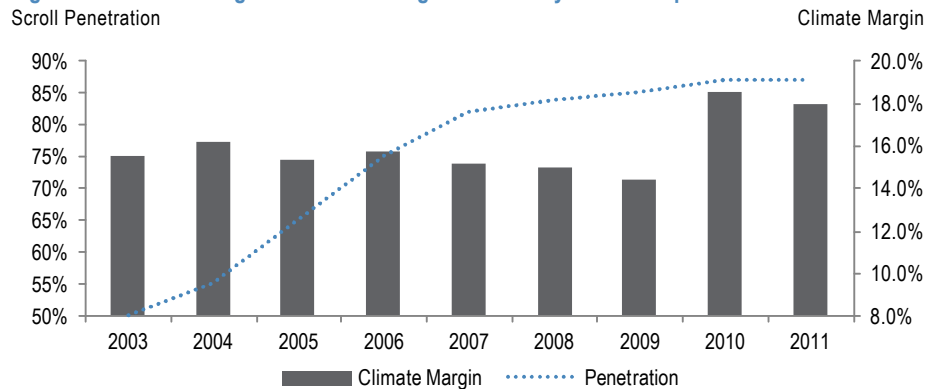
Additionally, given scroll compressors were a key to higher efficiency at a reasonable cost, Emerson saw even greater benefits from a price and share perspective. In its 10Ks, management pointed to average 2% annual revenue growth (7% in 2004 alone) from penetration gains over the course of the last cycle. The technology here was so strong that Bristol Compressors, the other main supplier, was sold in 2007 as part of the JCI/YRK deal for \$350 mm or ~0.5x of sales. At one point, following the transition to 13 SEER, management estimated scroll technology share would go from 50% to 80% of applications in the US.

Figure 406: Climate: Sales Growth from Penetration



Source: Company reports.

Figure 407: Climate Margins at Historical Highs Boosted by Scroll Compressor Penetration



Source: Company reports.

Looking back at the moving parts around the transition for Emerson shows a volatile pre-buy period that is instructive for this transition. Starting with orders, the company was negative y/y in July 2005, but over the course of August and September it ramped to “>20%+” growth in September on a combination of late season heat but then the impact of pre-buy. The company maintained “>20%+” through November before moving to “+15-20%” in December and “+10-15%” in January and “+5%” in March.

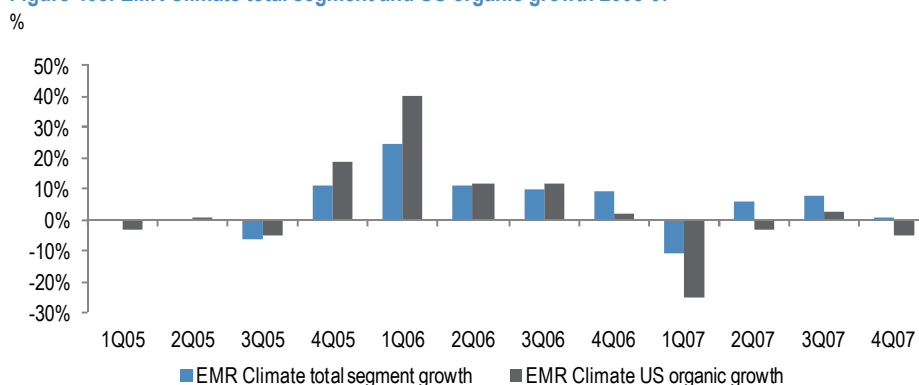
Table 147: EMR Climate orders growth 2005-06

Month	% Growth
Aug-05	+10-15
Sep-05	+>20
Oct-05	+>20
Nov-05	+>20
Dec-05	+15-20
Jan-06	+10-15
Feb-06	+10-15
Mar-06	+5
Apr-06	+5-10
May-06	+10-15
Jun-06	+>20
Jul-06	+>20
Aug-06	+10
Sep-06	-5-10
Oct-06	-10-15
Nov-06	-10-15
Dec-06	-5-10

Source: Company reports

On a quarterly results basis, the industry was not in good fundamental shape in the quarters leading up to the transition, with a decline in the US of 5% and an income decline of 12%. For FY4Q05, the segment put up 11% growth, with 19% growth in the US. Moving to FY2Q06, underlying sales in US climate were up 40%, with a 3% benefit to price across the segment. Management estimated at that time the impact from pre-buy was \$100 mm, or 20% of our estimate of annual US resi HVAC sales. Earnings went up 18% in the quarter, though the company had some inefficiencies related to higher material costs and overhead from the unusually high production runs. In total, on an annual basis, the company talked about share gains but also noted that margins for the new scrolls were higher than the legacy products.

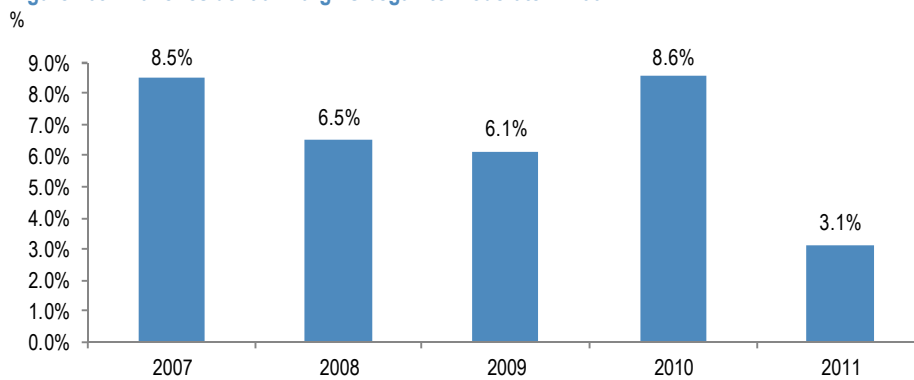
Figure 408: EMR Climate total segment and US organic growth 2005-07



Source: Company reports

Beyond the immediate years of the transition, as it became clear that the low end was commanding most of the volume, the higher end brands saw some margin compression. Indeed, even as 10 SEER began to get phased out of the market, 13 SEER became the new “battleground” on pricing for value players, and the pricing gap between 10 and 13 SEER was still wide enough that value players could undercut on pricing while still achieving decent margins. In our view, this was a key reason that the margin benefits OEMs saw from 2005 to 2006 began to moderate somewhat in 2007. This trend capitulated with the R410A transition.

Figure 409: Trane residential margins began to moderate in 2007



Source: Company reports.

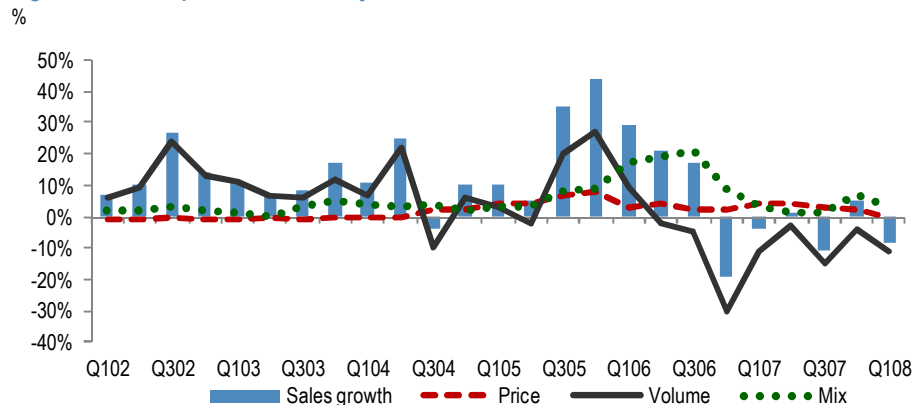
Case study: Examining the 13 SEER and refrigerant transitions through Lennox and Trane residential segments

We believe that Lennox's and Trane's residential segments serve as decent proxies for analyzing the impact of previous regulatory transitions on the overall HVAC market, and we can use the financial results of these businesses to draw conclusions on the effect of these transitions. Prior to Trane's acquisition by Ingersoll Rand at the end of 2007, the company reported detailed price/volume/mix components of its organic growth, allowing us to use this data to analyze residential HVAC trends from 2002-2007. Lennox began reporting this detailed price/volume/mix breakdown in 2006, allowing us to use this data to analyze residential HVAC trends from 2006 onwards. Below, we analyze these two time periods using each of these companies as a proxy for the residential HVAC market.

2002-2007: solid growth with mix benefits accelerated by 13 SEER transition

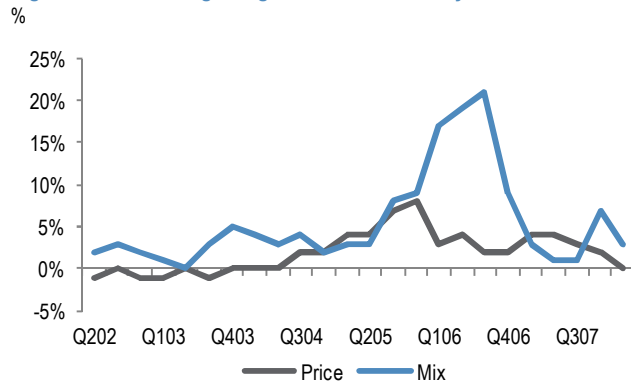
Examining Trane's results from 2002 through mid 2004 shows consistently solid sales growth with strong volumes, flat pricing, and decent mix benefits. Volumes slow somewhat from mid 2004 to mid 2005, offset by price and mix. Beginning in 2H2005, we see the effects from the pre-buy before the 13 SEER transition as volume growth jumps and then reverses in 2H2006. Mix also gets significantly better throughout 2006 as more lucrative 13 SEER products enter the market, a dynamic that stabilizes by 2007.

Figure 410: Trane price/volume/mix dynamics 2002-2007



Source: Company reports

Figure 411: Trane organic growth and volume dynamics 2002-2007



Source: Company reports

Figure 412: Trane price/mix dynamics 2002-2007

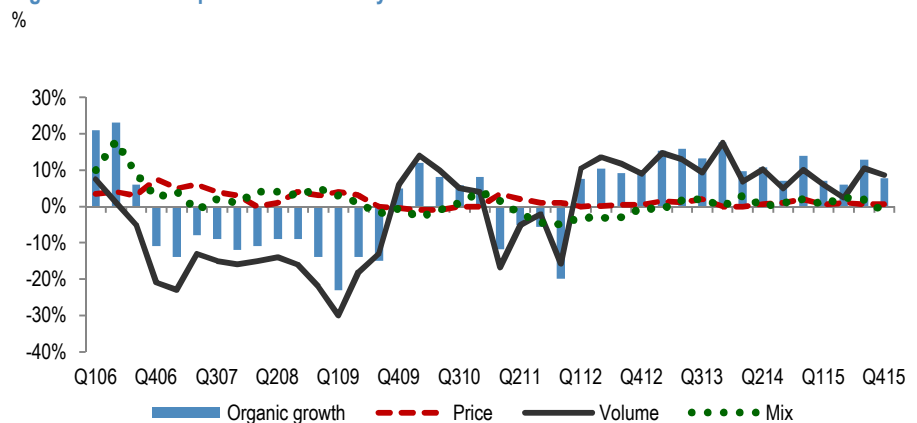


Source: Company reports

2006-2014: economic downturn and recovery impact volumes, with price/mix moderating from R-22 and a shift to the value segment

Examining Lennox's results from 2006 to 2014 show alternating downturn and recovery periods, with volumes driving organic growth results and price/mix having a more limited impact. Indeed, from 2007 onwards, we see that volumes and organic growth have fluctuated significantly, while price and mix have been relatively stable except during late 2011, when Lennox diversified to value products and also experienced a negative mix impact from participating in R-22 dry shipments in an effort to avoid losing market share to value competitors.

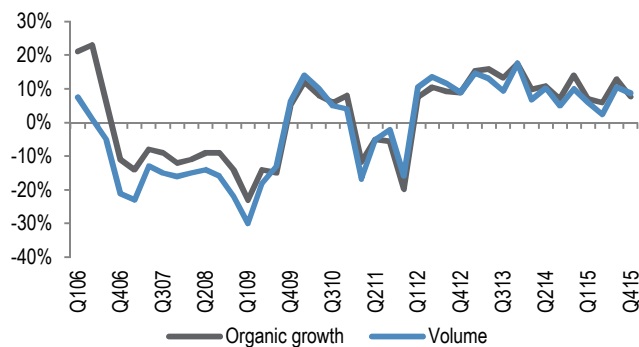
Figure 413: Lennox price/volume/mix dynamics 2006-2015



Source: Company reports

Figure 414: Lennox organic growth and volume dynamics 2006-2014

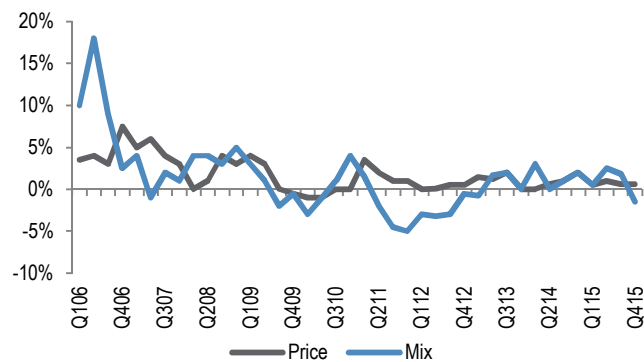
%



Source: Company reports

Figure 415: Lennox price/mix dynamics 2006-2014

%



Source: Company reports

A look back at the 2010 refrigerant changeover

The 2010 refrigerant changeover was something entirely different than the move to 13 SEER. Here, we had a regulation that was applicable to the entire industry and where the technical mechanics of the new products required a full system replacement, which dramatically raised first cost. There was also confusion around a loophole that allowed some players to continue to sell the banned product, driving some temporary share gain and margin pressure.

Background on refrigerant regulation

R-22 and R-410A are two types of refrigerant used in unitary air conditioners. R-22 pre-dates R-410A, and R-410A was developed later as a more environmentally friendly refrigerant. Keep in mind that the refrigerant is simply one aspect of the condensing unit. Outside of the compatibility of the indoor components, there is not a significant difference between the two refrigerants when it comes to the condensing unit. In other words, a 13-SEER R-22 outdoor unit will not, on its own, be meaningfully different than a 13-SEER R-410A. Beginning in 2010, new regulatory requirements mandated that OEMs were no longer allowed to ship newly manufactured equipment using the R-22 refrigerant. Components of R-22 systems, such as compressors, are still available to fix R-22 systems in the field, but the enforcement of this mandate calls for the refrigerant to be produced in progressively lower quantities according to a predetermined reduction in the allocations for new production to players like Honeywell and Dupont. The intent of this is gradually to wind down both the availability and cost of R-22, discouraging consumers from using related equipment. We also note that R-22 is slated to no longer be produced after 2020, meaning purchases of new systems today may have a shorter service life, a risk to the system owner.

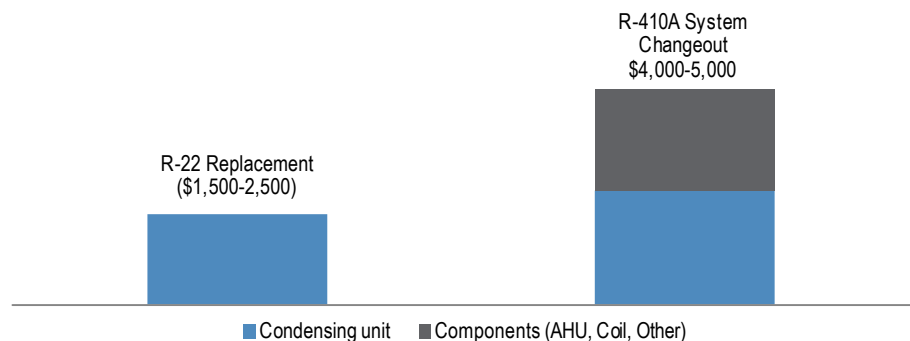
What was supposed to happen: similar unit growth, revenue/mix benefits

The conventional wisdom was that the transition to R-410A would benefit the industry, pulling through additional component sales as old units came due for replacement. This is because a customer switching from R-22 to R-410A not only has to replace the condensing unit but also has to change the indoor coil and, in many cases, the air handler (AHU), which are incompatible with the new refrigerant. In many cases, the customer will also buy a furnace, part of a complete system replacement. Assuming no change to replacement rates, this should have been a positive since these components are often sold by the same OEMs/distributors and therefore would drive additional revenues. To a lesser extent, there was a view that consumers making the jump to R-410A may be more likely to consider higher efficiency (14+ SEER) equipment, another mix benefit.

What actually happened: fewer unit replacements due to higher costs

Instead, however, the added component costs served to increase the effective cost of replacement for the consumer dramatically and turn the traditional “fix versus replace” dynamic on its head. Keep in mind that in an R-22 world, the fix versus replace decision was practically a non-decision for the consumer: a compressor replacement would cost around \$1,800-2,000, lasting ~3 years, while a unit replacement was \$1,800-2,500, lasting 10-12 years and coming with an extended warranty. An R-410A system replacement alters these economics, however, once the cost of the components is included. We estimate that, on average, the cost of a new air handler could be ~60% of the cost of a basic 13-SEER replacement unit, while a new coil could be ~30%, meaning that equipment costs for a full-system change-out could be close to twice that of a condensing unit only. There is also the additional labor cost for the installation, bringing the all-in costs of an R-410A system change-out to as much as 2.5x the cost of a traditional R-22 replacement. A new furnace, often encouraged in a system change-out, would be yet another incremental expense. Higher upfront costs meant consumers were more likely to fix, rather than replace, broken systems.

Figure 416: While the cost of an R-22/R-410A unit is similar, a system change-out can be ~2X more expensive when incorporating component costs



Source: J.P. Morgan estimates

The increase in repair behavior becomes clear when we look at the full spectrum of replacement options for a broken unit in 2010. Without the low-cost R-22 replacement option, a compressor replacement cost just 40% of the cost of a full-system change-out, the next available option. This made fixing a reasonable cash flow decision for a homeowner who was concerned primarily about first cost. Notably, the 30% 25C tax credit available at the time did not necessarily mitigate this issue. For consumers who could afford to replace the full system and make the R-410A transition, the tax credit provided a tailwind to high-efficiency units, allowing them to pick up a 16-SEER system for scarcely more than a standard 13-SEER R410A option. For the price-conscious buyer looking for a cheap unit replacement, however, we think the tax credit did little to help drive incremental unit demand.

Table 148: Without R-22 replacement option, system change-outs >2x cost of compressor repair

Estimates based on cooling system only (no furnace)

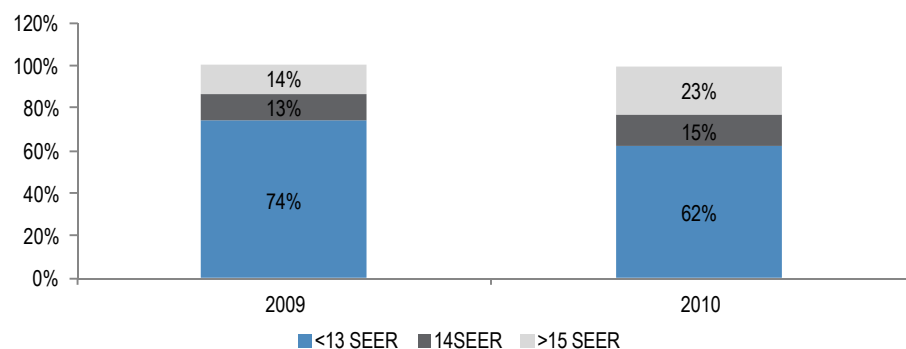
	Compressor Repair	New R-22 13-SEER (not available in '10)	New R-410a 13-SEER System	New R-410a 16-SEER System
Condensing unit/Compressor	1,500	1,750	2,250	3,000
Labor/install (condensing unit)	300-400	500	500	500
AHU/Coil			2,000	2,000
Labor/install (AHU/coil)			500	500
Total Estimated Cost	\$1,800-2,000	\$1,800-2,500	\$4,500-5,500	\$6,000+
Tax Credit Avail?	No	No	No	Yes
Tax Credit % Savings				30%, up to \$1,500 ~\$1,000
Total Net Upfront Cost	\$1,800-2,000	\$1,800-2,500	\$4,500-5,500	~\$5,000

Source: J.P. Morgan estimates

Mix was better in 2010 . . .

How did this all filter into 2010 industry results? There are several factors to consider, and we start first with mix. As expected, the percentage of 15+ SEER units were up to all-time highs in 2010, a combination of (a) tax credits for high-efficiency units and (b) muted replacement growth, meaning a greater percentage of the R410A units replaced were high efficiency. Given that each 16-SEER unit is typically ~20% higher than a comparable 13-SEER, we think positive mix added ~1.5% to industry revenues.

Figure 417: Industry SEER mix



Source: Company reports and J.P. Morgan estimates

. . . high-efficiency furnaces were also attractive in 2010 with 25C tax rebates . . .

R-410A was also a tailwind-strong year for furnaces in 2010 as full-system change-outs were more likely to include a furnace in addition to a new cooling unit. It's also important to keep in mind that, under the 25C tax credit, consumers were eligible for the full 30% credit (up to \$1,500) if their new system included a high-efficiency furnace. This was the case even if the A/C unit did not qualify for the tax credit. Thus, a consumer making the transition to a 13-SEER R410A refrigerant could add, say, a ~\$2,500 high-efficiency furnace for only another ~\$1,000 of upfront cost. As a result, not only were customers buying more furnaces, they were commonly buying the most efficient models at a dramatic discount.

Table 149: Illustrative table of furnace/tax credit replacement options (2010)

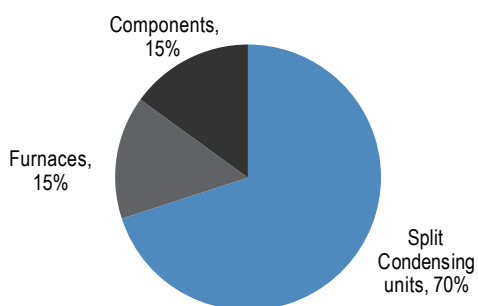
	New R-410a 13-SEER (A/C only)	New R-410a 13-SEER + H/E Furnace	New R-410a 16 SEER (A/C only)	New R-410a 16 SEER + H/E Furnace
Condensing unit	2,250	2,250	3,000	3,000
Furnace		2,500		2,500
Labor/install (furnace + condensing unit)	500	500	500	500
AHU/Coil/Other Components	2,000	2,000	2,000	2,000
Labor/install (AHU/coil)	500	500	500	500
Total Estimated Cost	\$5,000-5,500	\$7,500-8,000	\$6,000	\$8,500
Tax Credit Avail?	No	Yes	Yes	Yes
Tax Credit %		30%, up to \$1,500	30%, up to \$1,500	30%, up to \$1,500
Savings		~\$1,500	~\$1,000	~\$1,500
Total Net Upfront Cost	\$5,000-5,500	~\$6,000-6,500	~\$5,000	~\$7,000

Source: J.P. Morgan estimates

... and component volumes were up, an incremental help . . .

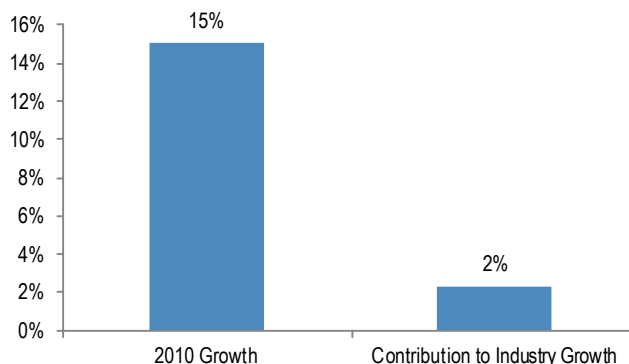
Also on the positive side, the R410A transition helped drive higher component volumes, as was expected. Indeed, looking at industry data on component volume in 2010 shows a mid-teens increase over 2009, driving “attachment” to ~90%, up 10% from ~80% the prior year. Given the price differential between components and condensing units, we estimate this added an incremental ~2% to overall industry revenue growth. Furnaces also had a strong year as more people changed out their entire systems, contributing ~2.5% to industry revenue growth (see our discussion in the next section).

Figure 418: Components ~15% of industry dollar value...
% of total value shipped



Source: J.P. Morgan estimates

Figure 419: ...growing 15% in 2010, but contributing only ~2% to growth rates



Source: J.P. Morgan estimates

... but demand destruction from R410A still looks significant

In the end, however, we think the R410A transition destroyed a meaningful amount of replacement demand in 2010. This is best demonstrated by breaking out the components of the y/y revenue growth. To start, we estimate the resi OEMs grew revenues ~7% on average in 2010, over 4.5% of which was driven by components (up 15%) and furnaces (up 13%), with core A/C splits up closer to 3.5%. Within split systems, mix added ~1.5%, while the modest growth in new housing added another ~0.5% (6% growth on ~10% of overall units). Additionally, the installed base due for replacement has grown by ~4%, meaning that with constant replacement rates, units should have seen a similar increase. Then there is weather in 2010, which was among the hottest in the last 30 years. While there is no simple rule of thumb for quantifying the impact as historical correlation has been all over the map, we estimate this drove ~7% of incremental sales growth in 2010.

Table 150: We think R-410A demand destruction weighed significantly on 2010 growth

% Y/Y growth, 2010	2010E
<i>Installed Base Growth</i>	4.0%
<i>Price</i>	0.0%
<i>Mix (Tax Credit)</i>	1.5%
<i>Housing</i>	0.6%
<i>Weather</i>	7.0%
<i>Weak Consumer/R410A Demand Destruction</i>	-9.8%
Total Splits Revenue	3.4%
Splits Condensing Unit Contribution	1.9%
Components: AHUs/Coils	2.1%
Furnaces	2.7%
Industry Revenue Growth	6.7%

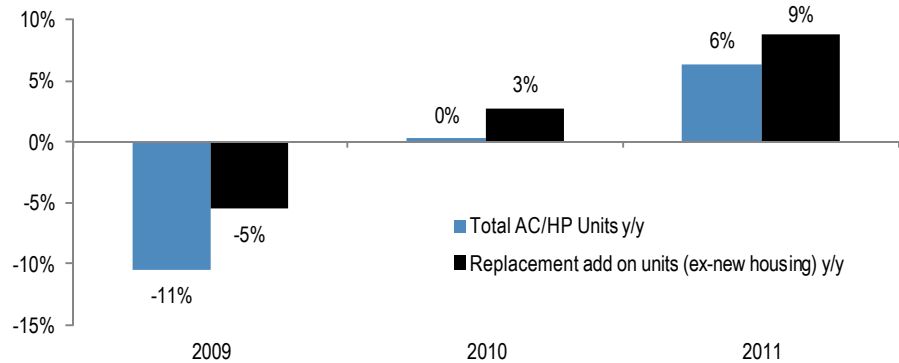
Source: AHRI, J.P. Morgan estimates

All things equal, the above factors suggest that split shipments growth should have been in the low teens versus the low-single-digit growth actually delivered, a ~10% gap that we think is attributable to consumer behavior. While some of this may have been incremental weakness in the underlying consumer, we note that traditional indicators like consumer confidence and home prices actually *improved* in 2010. Thus, we think the “sticker shock” around R-410A system change-outs drove much of this weakness, likely a 5-10% drag on overall industry growth.

R-22 dry ships made replacement (versus repair) more affordable in 2011

An additional wrinkle to the regulatory enforcement came in 2011, when OEMs found a loophole in the R-410A changeover. Specifically, OEMs were allowed to ship “dry” units charged with nitrogen but no refrigerant. These were then filled with R-22 once installed in the field, which was classified as an “aftermarket” sale and, therefore, allowable under the new regulations. These units were attractive to the homeowner, who could replace the outdoor condensing unit in an existing R-22 system without the additional expense of buying new indoor components like a coil. As a result, AC/heat pump shipments were up 6% in 2011 versus 0% in 2010. Most of these additional replacement units, we believe, came in lieu of compressor repairs.

Figure 420: Replacement units increased in 2011, helped by R-22 availability



Source: AHRI, J.P. Morgan estimates

Many distributors only reluctantly participated in R-22 . . .

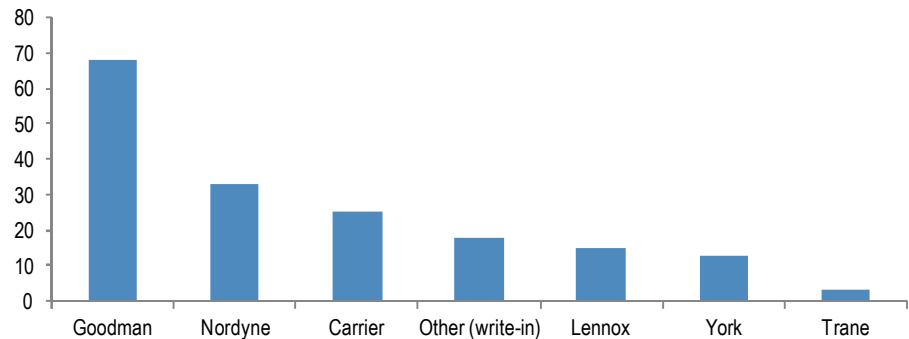
For much of the distribution channel, the return of R-22 was accepted only reluctantly. Although R-22 replacement parts and refrigerant are still available at least through 2020, many distributors view the sale of a dry-charged unit as doing the customer a disservice in the long run given uncertainty around the cost and availability of future repairs. Additionally, the industry has gone to great lengths to educate distributors and contractors on the benefits of R410A, and many participants view a return to R-22 as a step back given that, in the long run, consumers will have to switch anyway. Finally, as we discussed, the R410A transition has traditionally been viewed as a positive business proposition, enhancing mix through the sale of higher efficiency units as well as component sales. For these reasons, roughly two-thirds of the independent distributors in our survey actually prefer that the loophole be closed.

. . . and OEM response was mixed . . .

Similarly, the strategies among OEMs were mixed, with the biggest contrast coming between the value and premium players. Premium players have petitioned the EPA to oppose R-22 dry shipments, while value-oriented OEMs have defended the return of R-22. With regard to R-22 production, the value brands pursued this opportunity most aggressively, particularly Goodman, Nordyne, and Rheem. Among the premium-focused players, however, participation varied. Carrier was the most active, a point reinforced by our survey work, which helped it defend share. Lennox was also proactive in its participation, but it did so primarily through its Allied-brand units (~20% of segment sales) that were sold through third-party distribution. The premium orientation of Lennox's company-owned distribution also sold R-22, but it's a less natural fit. Trane, meanwhile, had minimal participation in 2011, which cost it market share that has only been partially made up since.

Figure 421: Degree of R-22 participation was also mixed by OEM

Question: Which brand(s) have been participating the most in R-22 dry-shipped units (select all that apply)



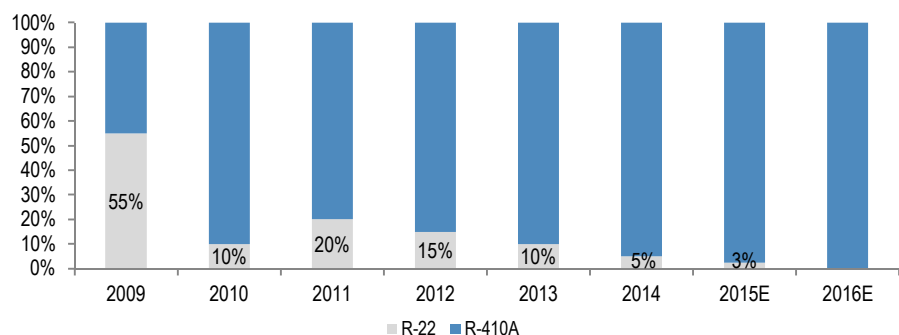
Source: JPM/HARDI 2011 HVAC Distributor Survey

... but “dry ships” saw persistent demand from cost-conscious consumers

The demand for R-22 dry-ship units generally proved more robust than expected, largely driven by capital-constrained consumers who could not afford the full R410A system change-out. There are no comprehensive data that track R-22 mix, and there are a wide range of estimates among the various suppliers, OEMs, and industry participants. Our best estimate is that R-22 represented ~20% of units shipped at their recent peak in 2011, going down to ~15% in 2012 and progressively lower over time. As historical perspective here, R-22 used to be the primary refrigerant, though some OEMs started to move forward on the R-410A transition in 2009. Note that R-22 sales did not go to zero in 2010, even after the manufacturing ban, as distributors stocked some product in 4Q09, which was sold out of inventory, but we think represented only ~10% of unit volume in 2010 (and a lower proportion of total revenues as R-22 is typically minimum efficiency).

Figure 422: R-22 as a % of total residential units

%



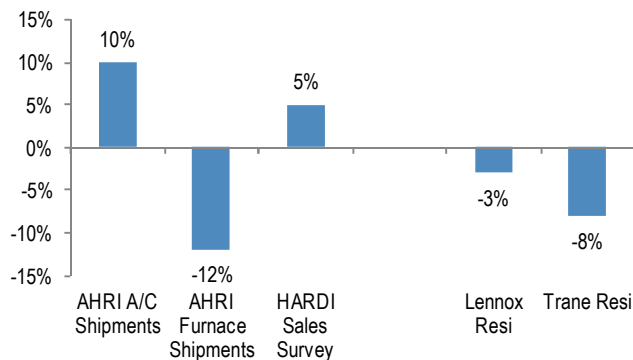
Source: J.P. Morgan estimates

R-22 impact most negative for high-end OEMs (Trane, Lennox)

The dislocation from the return of R-22 was significant, felt most at the premium OEMs that focused more on high-efficiency units. There are three primary issues here that impacted revenue. The first is share loss on cooling shipments as premium players lost out on the move to value products. Trane was hit the hardest here as its production of R-22 was negligible, while Lennox has indicated its Allied brand (~20% of segment sales, which participated more heavily in R-22) outgrew Lennox-branded products in 2011, evidence of a bifurcated market. In 2Q11, both Lennox and Trane talked about losing roughly “a point” of share in their core A/C markets, and given these companies’ high-teens market share, this would explain ~5% of the relative underperformance in 2011. The second issue is sales of furnaces and components, something OEMs had traditionally bundled in system-replacement sales but products rarely sold in an R-22 replacement. Lastly, there was the issue of cooling mix, as the R-22 units were almost always 13-SEER and therefore a mix headwind. For these reasons, revenue growth at Lennox’s and Trane’s residential businesses lagged most industry measures in 2Q11 and 3Q11, with Trane the hardest hit. The mix headwind also hurt margins and was arguably more negative for overall earnings. While there were some one-off items that exacerbated margin declines at both LII and IR, we estimate that core volume declines fell through the bottom line at a ~50% rate, worse than the usual ~30% volume decrementals, reflecting the negative mix impact from more R-22 and fewer high-efficiency units.

Figure 423: 2Q11 and 3Q11 resi growth rates at Lennox/Trane lagged industry data...

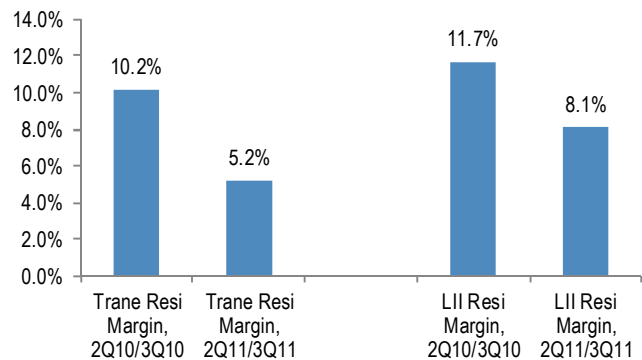
%Y/Y, 2Q and 3Q combined



Source: AHRI, HARDI, company reports

Figure 424: ...while margin performance was weak, driven by mix headwinds

Segment operating margin



Source: Company reports

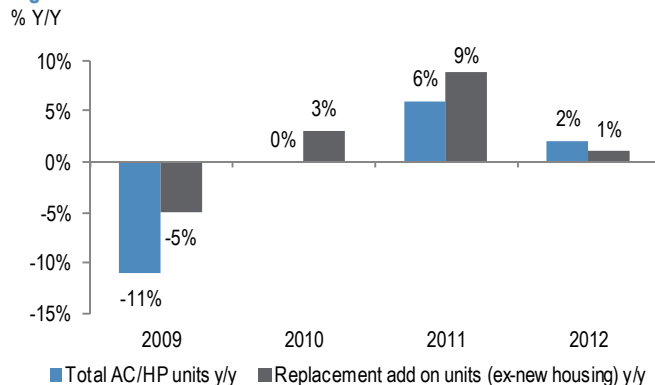
R-22 dry ships started to wind down in 2012

In 2012, dry shipped units remained a significant piece of the market, but their share was lower y/y, with more R-410A system sales. The most noticeable change came on the price of the R-22 refrigerant, as reductions in EPA production allocations for major suppliers accelerated, and producers like Honeywell began to raise prices, with increases on the order of ~50%. In our view, higher R-22 prices were not a direct near-term issue for sales as refrigerant is only ~5% of initial cost. Rather, the bigger concern was related to service as contractors were increasingly less comfortable selling an R-22 unit that would be increasingly expensive to repair in the future. The trajectory of the 2012 price increases was probably enough to deter further adoption. Instead of R-22 units, most OEMs began to focus on increasing R-410A sales. Most of the new R-410A unit demand, however, came at the 13 SEER level, which indicates that customers who would have bought dry ships in 2011 moved incrementally toward R-410A systems, but did so at the minimum efficiency due to continued price sensitivity.

Bottom line: unit growth lower, but more full system sales

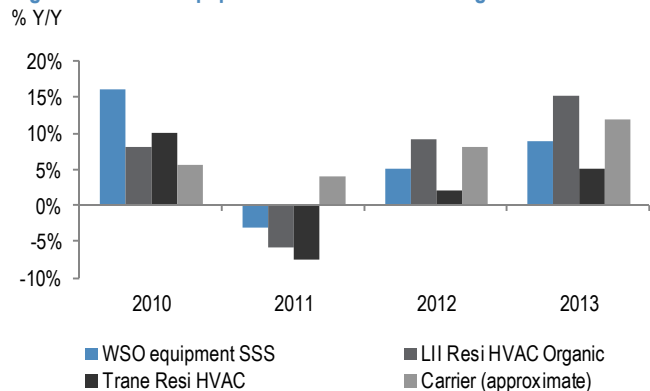
The end result was that AHRI cooling shipment growth was weaker in 2012, up just 2% versus the 6% seen in 2011. OEM revenues and distributor revenues, however, were better than this as the industry sold more full systems (i.e., indoor units).

Figure 425: Units were weaker in 2012...



Source: AHRI, J.P. Morgan estimates

Figure 426: ...but equipment revenues were stronger



Source: Company reports, J.P. Morgan estimates

The winding down of dry shipments from 2012 continued into 2013 as noise from this dynamic settled and became less of an issue. Dry shipments currently represent <5% of the market, and we anticipate minimal levels moving forward.

Appendix IV: EIA Data

In its Residential Buildings Characteristics Report, the EIA details what they believe to be the state of the installed air conditioning stock. The table below details these stats which we references over the course of the report. This data is from 2015 and so should be used more for backdrop.

Figure 427: Air conditioning in U.S. homes by climate region, 2015
housing units in mm

	Total U.S. ²	Very cold/ cold	Mixed- humid	Mixed- dry/ Hot-dry	Hot- humid	Marine
All homes	118.2	42.5	33.5	12.7	22.8	6.7
Air-conditioning equipment						
Use air-conditioning equipment	102.8	36.2	31.6	10.1	21.4	3.5
Do not use air-conditioning equipment	15.4	6.3	1.9	2.7	1.4	3.2
Type of air-conditioning equipment used (more than one may apply)						
Use central air-conditioning equipment	76.1	23.5	23.4	8.6	18.4	2.2
Without a heat pump	55.4	20.7	15.1	6.5	12.1	1.0
With a heat pump	20.7	2.8	8.3	2.1	6.3	1.1
Use individual air-conditioning units	32.1	14.3	10.3	1.9	4.1	1.5
With 1 unit	15.9	7.6	4.6	1.3	1.5	1.0
With 2 units	9.6	4.4	3.1	0.4	1.2	0.4
With 3 or more units	6.6	2.2	2.6	0.2	1.4	Q
Do not use air-conditioning equipment	15.4	6.3	1.9	2.7	1.4	3.2
Central air-conditioning equipment age						
Less than 2 years old	8.3	2.3	2.5	0.8	2.4	0.3
2 to 4 years old	11.7	3.3	3.6	1.6	3.0	0.3
5 to 9 years old	22.4	6.9	6.4	2.2	6.4	0.6
10 to 14 years old	17.2	5.3	5.6	2.0	3.8	0.5
15 to 19 years old	9.2	3.2	2.9	1.1	1.5	0.3
20 or more years old	7.3	2.5	2.3	0.8	1.4	0.2
Do not use central air-conditioning equipment	42.1	19.0	10.1	4.1	4.4	4.5
Have thermostat for central air-conditioning equipment						
Yes	74.7	23.1	23.0	8.3	18.2	2.1
Programmable thermostat	47.9	15.4	13.8	6.3	10.6	1.9
Non-programmable thermostat	26.8	7.7	9.2	2.0	7.6	0.2
No	1.4	0.4	0.4	0.3	Q	Q
Do not use central air-conditioning equipment	42.1	19.0	10.1	4.1	4.4	4.5
Central air-conditioning equipment control						
Set one temperature and leave it there most of the time	34.0	9.8	12.2	3.1	8.3	0.6
Manually adjust the temperature at night or when no one is at home	19.6	5.4	5.9	2.0	5.9	0.4
Program the thermostat to automatically adjust the temperature during the day and night at certain times	13.7	5.2	4.1	1.3	2.4	0.6
Turn equipment on or off as needed	8.8	3.2	1.2	2.1	1.8	0.6
Household does not have control over the equipment	Q	N	Q	N	Q	N
Do not use central air-conditioning equipment	42.1	19.0	10.1	4.1	4.4	4.5
Most-used individual air-conditioning unit age						
Less than 2 years old	6.4	2.4	2.0	0.5	1.0	0.5
2 to 4 years old	10.0	4.3	3.2	0.6	1.5	0.4
5 to 9 years old	9.8	4.8	3.2	0.4	1.0	0.4
10 to 14 years old	3.7	1.7	1.1	0.3	0.4	0.2
15 to 19 years old	1.3	0.6	0.4	Q	Q	Q
20 or more years old	1.1	0.6	0.4	Q	Q	Q
Do not use individual air-conditioning units	86.1	28.2	23.2	10.8	18.7	5.2
Most-used individual air-conditioning unit control						
Set one temperature and leave it there most of the time	9.8	4.2	3.2	0.3	1.6	0.5
Manually adjust the temperature at night or when no one is at home	5.8	2.8	1.7	0.4	0.7	0.2
Program the thermostat to automatically adjust the temperature during the day and night at certain times	1.5	0.6	0.6	Q	Q	Q
Turn equipment on or off as needed	14.8	6.6	4.7	1.1	1.7	0.7
Some other way	Q	Q	N	Q	N	Q
Do not use individual air-conditioning units	86.1	28.2	23.2	10.8	18.7	5.2
Summer indoor daytime temperature when someone is home						
69 degrees or less	19.9	9.1	6.7	1.1	2.2	0.8
70 degrees	17.4	6.4	6.5	1.2	2.6	0.6

71 to 73 degrees	20.5	7.6	7.0	1.3	4.0	0.6
74 to 76 degrees	26.3	8.7	7.6	2.4	6.7	0.8
77 to 79 degrees	13.0	2.9	2.9	2.4	4.6	0.2
80 degrees or more	5.7	1.5	0.9	1.7	1.3	0.4
Do not use air-conditioning equipment	15.4	6.3	1.9	2.7	1.4	3.2
Summer indoor daytime temperature when no one is home						
69 degrees or less	14.0	6.6	4.5	0.7	1.4	0.8
70 degrees	13.0	5.0	5.0	0.6	2.1	0.3
71 to 73 degrees	14.5	5.6	5.6	0.6	2.2	0.6
74 to 76 degrees	25.5	9.9	7.6	1.6	5.6	0.8
77 to 79 degrees	15.9	4.1	4.5	1.8	5.2	0.3
80 degrees or more	19.9	5.0	4.4	4.8	5.0	0.7
Do not use air-conditioning equipment	15.4	6.3	1.9	2.7	1.4	3.2
Summer indoor temperature at night						
69 degrees or less	25.8	11.4	7.9	1.3	3.8	1.3
70 degrees	20.0	7.3	7.3	1.6	3.0	0.8
71 to 73 degrees	19.1	7.0	6.4	1.0	4.1	0.5
74 to 76 degrees	23.3	7.1	6.8	2.6	6.2	0.6
77 to 79 degrees	10.4	2.6	2.3	2.0	3.3	0.2
80 degrees or more	4.2	0.9	0.8	1.5	1.0	Q
Do not use air-conditioning equipment	15.4	6.3	1.9	2.7	1.4	3.2
Air-conditioned basement						
Yes	14.2	9.2	4.7	Q	N	0.2
No	17.5	11.6	5.3	Q	Q	0.4
Not asked (air-conditioned homes with no basement)	39.9	5.1	11.4	6.3	14.7	2.4
Not asked (un-air-conditioned homes, apartments, and mobile homes)	46.7	16.6	12.1	6.2	7.9	3.8
Air-conditioned attic						
Yes	1.6	0.8	0.5	Q	Q	Q
No	39.9	13.6	12.8	3.0	9.2	1.5
Not asked (air-conditioned homes with no attic)	30.0	11.5	8.1	3.4	5.5	1.4
Not asked (un-air-conditioned homes, apartments, and mobile homes)	46.7	16.6	12.1	6.2	7.9	3.8
Air-conditioned, attached garage						
Yes	1.0	0.3	0.3	Q	0.3	Q
No	41.1	14.8	10.3	5.1	8.8	2.0
Not asked (air-conditioned homes with no attached garage)	29.4	10.8	10.7	1.3	5.8	0.8
Not asked (un-air-conditioned homes, apartments, and mobile homes)	46.7	16.6	12.1	6.2	7.9	3.8
Dehumidifiers and usage						
Have a dehumidifier	16.7	10.6	4.6	0.3	0.9	0.4
Do not use	0.4	0.2	Q	Q	Q	N
Used less than 4 months	5.5	3.8	1.2	Q	0.2	Q
Used 4 to 6 months	6.5	4.1	1.9	Q	0.3	Q
Used 7 to 9 months	2.0	1.1	0.6	N	Q	Q
Used 10 to 11 months	Q	Q	Q	N	Q	N
Turned on all 12 months	2.1	1.2	0.8	Q	Q	Q
Do not have a dehumidifier	101.5	31.9	28.9	12.4	21.9	6.3
Use an evaporative or swamp cooler (asked only in arid areas)						
Yes	2.8	1.0	Q	1.2	0.4	Q
No	54.8	4.8	9.9	11.5	22.0	6.5
Not asked	60.6	36.7	23.4	N	0.4	N
Fan types used (more than one may apply)						
Ceiling fans	85.1	29.2	24.1	8.9	19.2	3.6
Floor, window, or table fans	54.4	22.2	14.5	5.6	8.5	3.5
Whole house fans	6.1	2.1	1.9	0.7	0.8	0.6
Attic fans	8.7	2.9	3.7	0.5	1.1	0.5
Number of ceiling fans used						
0	33.1	13.3	9.4	3.8	3.6	3.0
1	21.3	8.8	5.5	2.8	2.5	1.5
2	18.8	7.3	5.3	1.7	3.6	1.0

3	15.2	5.7	4.0	1.2	3.9	0.5
4 or more	29.8	7.5	9.3	3.2	9.2	0.6

Source: EIA.

Appendix V: Financial Analysis of Major Players

In this section, we take a look across the industry from a financial perspective, looking at key metrics of the various OEMs and suppliers.

Margins

Operating margins for the HVAC OEMs historically averaged in the high-single-digits range last cycle, but have steadily risen this cycle with many OEMs now in the mid to high teens. Profitability for the key suppliers has generally been about in line with the OEMs, but with Emerson Climate Solutions notably above.

Table 151: Operating Margin Comparison

% segment operating margin, excludes extraordinary items such as restructuring charges where appropriate

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OEMs										
IR/Trane- total company	7.3%	8.5%	8.9%	9.6%	10.9%	11%	11.9%	11.7%	12.2%	12.8%
Climate Solutions Segment	7.7%	8.4%	9.0%	10.4%	12.1%	12.7%	14.6%	14.1%	14.3%	14.6%
Goodman Global	17.3%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lennox Intl	8.5%	7.0%	7.6%	9.4%	10.1%	10.9%	12.9%	13.4%	14.8%	16.2%
LII Resi HVAC Segment	11.0%	6.9%	7.5%	11.4%	13.6%	14.9%	17.4%	17.5%	17.9%	20.3%
LII Commercial HVAC	11.2%	11.3%	12.7%	14.0%	14.1%	14.7%	16.3%	16.2%	17.5%	17.5%
JCI Building Efficiency Segment	5.3%	5.0%	5.8%	6.7%	7.0%	8.6%	12.7%	13.2%	13.2%	13.5%
NA systems & services	7.6%	7.9%	9.9%	11.3%	10.5%	11.9%	n/a	n/a	n/a	n/a
Carrier	9.3%	9.3%	n/a	n/a	n/a	n/a	n/a	15.9%	15.4%	14.8%
HVAC Segment	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18.3%	17.9%	17.2%
CCS (UTX)	10.8%	12.2%	14.1%	15.7%	17.0%	17.5%	18.1%	17.6%	16.2%	16.0%
Daikin	6.5%	6.7%	6.9%	8.8%	10.0%	10.7%	11.3%	11.1%	11.1%	10.4%
Daikin HVAC Segment	6.4%	5.8%	6.3%	8.8%	10.0%	10.6%	11.4%	10.9%	10.7%	10.2%
Aaon Inc	13.4%	9.0%	14.6%	17.4%	19.1%	19.9%	20.7%	18.3%	12.8%	14.3%
Nortek	3.7%	2.9%	5.8%	3.8%	1.7%	3.4%	9.7%	12.6%*	13.9%*	14.9%*
Resi HVAC segment (Nordyne)	5.0%	0.4%	2.2%	3.2%	4.4%	0.7%	n/a	n/a	n/a	n/a
OEM average	9.0%	7.3%	9.1%	10.3%	11.0%	12.0%	14.3%	14.1%	13.6%	14.1%
Suppliers										
EMR Climate	18.2%	17.7%	17.7%	18.5%	21.3%	21.3%	23.0%	23.4%	22.3%	20.9%
RBC Electrical / Climate Solutions	10.5%	8.8%	9.5%	10.3%	11.7%	13.9%	13.8%	14.4%	15.5%	16.9%
Honeywell PMT	15.8%	18.4%	18.7%	18.8%	17.9%	20.9%	20.2%	21.3%	21.8%	22.5%
Tecumseh	-7.0%	-7.4%	2.3%	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AO Smith	5.5%	9.7%	12.4%	12.4%	13.0%	16.2%	17.5%	17.7%	18.0%	16.1%
Supplier Average	8.6%	9.4%	12.1%	15.0%	16.0%	18.1%	18.6%	19.2%	19.4%	19.1%

Source: Company reports and J.P. Morgan estimates; *Goodman's 2010 results reflect first 9 months, Nortek's 2017-2019 results are for air management only, as per Melrose presentations/reports

Gross margin is harder to examine comprehensively given that many of the diversified conglomerates do not fully break out gross profits by segment. For the HVAC OEMs, however, we believe gross margins typically average in the ~30% range, something reinforced now that Trane and Carrier are pure plays.

Table 152: Gross Margin Comparison

% gross margin, excludes extraordinary items

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ingersoll-Rand	27.2%	28.1%	29.0%	28.8%	29.4%	30.3%	30.1%	31.0%	n/a	n/a	n/a
Trane	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	30.4%	30.5%	30.5%
Lennox Intl Inc	27.7%	28.8%	25.2%	24.5%	26.9%	27.0%	28.0%	29.6%	29.3%	29.6%	28.3%
Johnson Controls	12.5%	15.4%	14.8%	14.7%	15.6%	15.5%	17.5%	31.5%	31.0%	29.9%	28.4%
UTX- CCS/Carrier	24.3%	26.4%	26.6%	27.9%	29.1%	30.4%	30.5%	30.6%	29.6%	29.4%	29.1%
Smith (A.O.)Corp	28.7%	29.9%	30.0%	33.6%	35.9%	36.5%	39.8%	41.7%	41.1%	41.0%	39.5%
Emerson Elec Co	37.6%	39.6%	39.5%	40.0%	40.3%	43.8%	43.1%	43.1%	42.0%	42.9%	42.5%
Regal Beloit	23.2%	24.5%	23.7%	24.3%	25.3%	24.5%	26.6%	26.8%	26.3%	26.5%	26.6%
Honeywell Intl	22.3%	23.6%	21.8%	24.9%	27.4%	28.2%	30.4%	30.9%	32.0%	30.5%	33.7%
Aaon Inc	27.5%	22.6%	17.4%	23.3%	28.0%	30.4%	30.3%	30.8%	30.5%	23.9%	25.4%
Daikin Inds	31.2%	31.2%	30.5%	30.1%	31.8%	33.9%	34.8%	35.8%	34.9%	35.0%	34.7%
Tecumseh Prod-A	6.6%	9.0%	4.4%	7.6%	9.5%	9.8%	12.3%	n/a	n/a	n/a	n/a
Nortek's Total	28.0%	26.7%	26.8%	29.1%	28.9%	29.1%	28.8%	n/a	n/a	n/a	n/a
Goodman Global	30.3%	31.2%	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sector Average	25.2%	25.9%	24.1%	25.7%	27.3%	28.3%	29.4%	33.2%	32.7%	31.9%	31.9%

Source: Company reports and J.P. Morgan estimates; *Goodman's 2010 results reflect first 9 months

R&D

Research and development expenses are typically reported at the parent company level and will vary depending on business mix (i.e., HON has very high spending for their aerospace businesses). For the HVAC-focused businesses, however, R&D will typically run between 1% and 2% of sales.

Table 153: R&D Spending Comparison

R&D/Sales

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ingersoll-Rand	1.7%	1.7%	2.0%	1.8%	1.6%	1.5%	1.5%	1.9%	1.9%	1.8%
Lennox Intl Inc	1.6%	1.5%	1.9%	1.7%	1.8%	1.8%	1.8%	1.9%	2.0%	1.9%
Johnson Controls	2.1%	2.1%	2.4%	2.4%	1.8%	1.9%	1.1%	1.2%	1.2%	1.3%
UTX- CCS/Carrier	n/a	n/a	n/a	n/a	1.8%	1.8%	1.8%	2.0%	2.1%	2.2%
Smith (A.O.)Corp	2.5%	2.5%	2.7%	2.7%	2.9%	2.9%	3.0%	2.9%	2.9%	2.9%
Emerson Elec Co	2.2%	2.3%	2.2%	2.3%	3.1%	3.1%	2.3%	2.2%	2.5%	2.5%
Honeywell Intl	4.5%	4.9%	4.9%	4.6%	4.7%	4.8%	4.7%	4.5%	4.3%	4.2%
Aaon Inc	1.5%	1.8%	1.2%	1.6%	1.8%	2.1%	3.1%	3.2%	3.1%	3.2%
Daikin Inds	2.8%	2.7%	2.7%	2.6%	2.3%	2.2%	2.6%	2.7%	2.6%	2.7%
Sector Average	2.4%	2.4%	2.5%	2.5%	2.4%	2.5%	2.4%	2.5%	2.5%	2.5%

Source: Company reports

Asset Intensity/Efficiency

Last cycle, capex/sales among the North American OEMs had typically run at ~2% of sales, or slightly over 100% of depreciation. With the downturn in 2008-09, however, capex came down dramatically with a fair amount of excess capacity at lower sales levels (particularly in North America), and has since gone back up to ~2% of sales, over 100% of depreciation.

Table 154: Capex/Sales Comparison

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OEMs										
IR (Trane or combined Climate/Resi Segments)	1.7%	1.1%	1.2%	2.0%	1.8%	1.9%	1.4%	2.0%	2.3%	1.6%
LII Resi HVAC	1.4%	0.9%	1.0%	2.2%	2.3%	1.5%	1.8%	1.8%	2.0%	2.6%
LII Commercial HVAC	1.0%	0.9%	1.1%	1.3%	1.6%	1.0%	1.3%	1.9%	1.3%	1.2%
JCI Building Efficiency	0.9%	1.1%	1.2%	1.4%	1.7%	2.5%	2.4%	2.9%	2.2%	2.4%
CCS/Carrier (UTX)	1.3%	1.6%	1.6%	1.6%	1.4%	1.6%	2.0%	1.8%	1.4%	1.3%
Nortek Resi HVAC segment (Nordyne)	0.6%	0.7%	0.4%	1.5%	1.3%	n/a	n/a	n/a	n/a	n/a
Daikin HVAC	2.7%	3.6%	3.3%	2.3%	3.4%	3.0%	5.0%	4.0%	3.1%	5.0%
OEM average	1.3%	1.5%	1.4%	1.8%	1.9%	1.9%	2.3%	2.3%	2.1%	2.3%
Suppliers										
EMR Climate	2.7%	3.0%	2.8%	2.6%	2.8%	3.3%	3.2%	3.9%	4.7%	5.1%
Honeywell	2.0%	2.2%	2.3%	2.4%	2.7%	2.8%	2.8%	2.5%	2.0%	2.3%
A.O. Smith	3.5%	3.1%	3.6%	4.5%	3.7%	2.9%	3.0%	3.1%	2.7%	2.2%
RBC Climate Solutions	n/a	n/a	n/a	n/a	1.5%	1.8%	1.6%	1.4%	1.7%	2.4%
Supplier Average	2.7%	2.8%	2.9%	3.2%	2.7%	2.7%	2.7%	2.7%	2.8%	3.0%

Source: Company reports

Table 155: Capex/D&A Comparison

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OEMs										
IR (Trane or combined Climate/Resi Segments)	33%	35%	35%	51%	44%	34%	35%	63%	72%	52%
LII Resi HVAC	89%	56%	69%	167%	190%	136%	175%	156%	170%	197%
LII Commercial HVAC	78%	78%	102%	124%	152%	89%	117%	183%	135%	90%
JCI Building Efficiency	86%	123%	123%	117%	130%	136%	114%	76%	68%	71%
CCS/Carrier (UTX)	26%	34%	64%	58%	42%	47%	55%	75%	74%	73%
Nortek Resi HVAC segment (Nordyne)	19%	20%	16%	68%	59%	n/a	n/a	n/a	n/a	n/a
Daikin HVAC	86%	143%	134%	90%	141%	205%	166%	159%	121%	135%
OEM average	62%	76%	78%	96%	108%	108%	110%	115%	109%	103%
Suppliers										
EMR Climate	70%	87%	80%	77%	110%	102%	91%	113%	122%	126%
Honeywell	90%	113%	134%	141%	164%	160%	151%	144%	115%	125%
A.O. Smith	129%	114%	128%	164%	144%	115%	124%	134%	118%	82%
RBC Climate Solutions	n/a	n/a	n/a	n/a	37%	65%	61%	61%	84%	118%
Supplier Average	96%	105%	114%	127%	114%	111%	107%	113%	111%	113%

Source: Company reports

Table 156: Asset Turnover Comparison

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OEMs										
IR (Trane or combined Climate/Resi Segments)	0.70	0.76	0.64	0.70	0.74	0.78	0.79	0.63	0.68	0.68
Lennox Intl Inc	1.53	1.67	1.74	1.97	1.91	2.06	2.07	2.03	2.02	1.85
<i>LII Resi</i>	2.82	2.59	3.02	3.31	3.07	2.96	3.07	2.78	2.66	2.17
<i>LII Commercial</i>	2.52	2.78	2.50	2.53	2.51	2.47	2.45	3.00	2.58	2.32
Johnson Controls	1.38	1.47	1.38	1.33	1.33	1.19	0.45	0.52	0.64	0.57
CCS/Carrier (UTX)	1.43	1.43	1.36	1.33	1.39	1.35	1.34	1.31	0.85	0.83
Nortek	1.06	1.09	1.15	1.18	1.21	1.16	n/a	n/a	n/a	n/a
<i>Resi HVAC segment (Nordyne)</i>	2.30	2.06	2.52	2.68	1.60	n/a	n/a	n/a	n/a	n/a
Daikin HVAC	1.15	1.15	0.77	0.99	0.93	1.02	0.94	1.03	1.00	0.96
OEM Average	1.50	1.62	1.66	1.76	1.62	1.57	1.44	1.48	1.37	1.34
Suppliers										
EMR Climate	1.77	1.82	1.68	1.72	1.78	1.71	1.64	1.73	1.52	1.49
Honeywell Intl	0.88	0.92	0.90	0.86	0.89	0.78	0.73	0.68	0.72	0.63
A.O. Smith	1.28	0.73	0.85	0.90	0.94	0.96	0.93	0.94	1.04	0.98
RBC Climate Solutions	n/a	n/a	n/a	n/a	1.35	1.11	1.09	1.09	1.13	1.10
Supplier Average	1.31	1.16	1.14	1.16	1.24	1.14	1.10	1.11	1.06	1.05

Source: Company Reports

Companies Discussed in This Report (all prices in this report as of market close on 26 February 2021)

Emerson Electric Co.(EMR/\$85.90/OW), Honeywell(HON/\$202.35/OW), Johnson Controls(JCI/\$55.79/N), Lennox International(LII/\$279.77/UW), Trane Technologies(TT/\$153.24/N), Watsco(WSO/\$243.10/N)

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